States
ment of
lture

e and
ion

ngton, D.C.

September 1981

The National Plant Germplasm System

Current Status (1980)
Strengths and Weaknesses
Long-Range Plan (1983-1997)

United States
Department of
Agriculture

National Agricultural Library

THE NATIONAL PLANT GERMPLASM SYSTEM

I. Current Status (1980)
II. Strengths and Weaknesses
III. Long-Range Plan (1983-1997)

Science and Education
U.S. Department of Agriculture
Washington, DC 20250

October 20, 1981

C O N T E N T S

MEMBERSHIP OF GERMPLASM TASK FORCE
AND
STEERING COMMITTEE

TASK FORCE

Name	Address
Charles Murphy Chairman	Program Coordinator, Germplasm USDA-S&E-SECO BARC-West, Building 005 Beltsville, MD 20705
Quentin Jones Technical Advisor	Assistant to Deputy Administrator for Germplasm USDA-S&E-ARS-NPS BARC-West, Building 005 Beltsville, MD 20705
Sharon Kenworthy Technical Assistant	Plant Introduction Office USDA-S&E-ARS-NER BARC-West, Building 001 Beltsville, MD 20705
Robert Marshak Advisor	USDA-S&E-SECO BARC-West, Building 005 Beltsville, MD 20705
Gilbert Hersh Advisory	LISA-GRIP Colorado State University 304 Aylesworth Fort Collins, CO 80523

Technical Work Group

Louis Bass	National Seed Storage Laboratory USDA-S&E-ARS-WR Colorado State University Fort Collins, CO 80523
Stephen Baenziger	USDA-S&E-ARS-NER BARC-West, Building 001 Beltsville, MD 20705
John Bouwkamp	Department of Horticulture University of Maryland College Park, MD 20742
Byrd Curtis	Cargill Research Farm 2540 East Drake Road Fort Collins, CO 80521

Sam Dietz	USDA-S&E-ARS-WR Regional Plant Introduction Station Washington State University Pullman, WA 99164
Jim Duke	USDA-S&E-ARS-NER BARC-East, Building 265 Beltsville, MD 20705
Wilson Foote	Associate Director Agricultural Extension Service Oregon State University Corvallis, OR 97331
Steve Telleen	LISA-GRIP Colorado State University 304 Aylesworth Fort Collins, CO 80523
David Timothy	Department of Crop Science North Carolina State University Raleigh, NC 27650
George White	Plant Introduction Office USDA-S&E-ARS-NER BARC-West, Building 001 Beltsville, MD 20705

STEERING COMMITTEE

Thomas Army Cochairman	Deputy Administrator National Program Staff USDA-S&E-ARS BARC-West, Building 005 Beltsville, MD 20705
Ernest Corley Cochairman	Director Science and Education Coordination Office USDA-S&E BARC-West, Building 005 Beltsville, MD 20705
Charles Murphy Executive Secretary	Program Coordinator, Germplasm USDA-S&E-SECO BARC-West, Building 005 Beltsville, MD 20705
Clarence Grogan	Assistant Deputy Administrator USDA-S&E-CSRS 6017 South Building Washington, DC 20250

Charles Beer	Deputy Adminsitrator Agricultural Programs USDA-S&E-ES 5051 South Building Washington, DC 20250
Lark Carter	Assistant Director Office of Higher Education USDA-S&E Room 426-A, Administration Building Washington, DC 20250
Molly Frantz (Informal)	Office of Management and Budget 8025 New Executive Office Building 726 Jackson Place, NW. Washington, DC 20503

General Accounting Office (GAO) Representative (informal)

Office of Technology Assessment (OTA) Representative (informal)

Congressional Representatives (informal)
- Senate Agriculture Appropriations Subcommittee
- House Agriculture Appropriations Subcommittee
- House Agriculture-Department Operations, Research, and Foreign Agriculture Subcommittee

ACKNOWLEDGMENT

The Task Force and Steering Committee were assisted by Risë Pennell (S&E-SECO), who was responsible for administrative, editorial, and secretarial tasks necessary for the report's preparation and finalization.

ABBREVIATIONS

AID	Agency for International Development
APGC	Association of Plant Germplasm Curators
APHIS	Animal and Plant Health Inspection Service, USDA
AR	Agricultural Research, SEA, USDA
ARS	Agricultural Research Service, USDA
BARC	Beltsville Agricultural Research Center, USDA
BLM	Bureau of Land Management
CAC	Crop Advisory Committee
CDSD	Communication and Data Services Division, USDA
CR	Cooperative Research, SEA, USDA
CSRS	Cooperative State Research Service, USDA
DBA	Data Base Administrator
DBM	Data Base Manager
DBMS	Data Base Management System
EBL	Economic Botany Laboratory, BARC
ES	Extension Service, USDA
FAO	Food and Agriculture Office
FS	Forest Service, USDA
FY	Fiscal Year
GAO	General Accounting Office
GRIP	Germplasm Resources Information Project
GRL	Germplasm Resources Laboratory, BARC
HE	Higher Education, USDA
IBPGR	International Board for Plant Genetic Resources
JC	Joint Council on Food and Agricultural Sciences

LRP	Long-Range Plan
MITA	Mayaguez Institute for Tropical Agriculture
NAS	National Academy of Science
NCI	National Cancer Institute
NOIC	National Oat Improvement Committee
NPEC	National Plant Exploration Committee
NPGC	National Plant Germplasm Committee
NPGRB	National Plant Germplasm Resources Board
NPGS	National Plant Germplasm System
NPS	National Program Staff, ARS, USDA
NRPL	National Research Program Leader, NPS
NSSL	National Seed Storage Laboratory
NWIC	National Wheat Improvement Committee
NTA	National Technical Advisor
OMB	Office of Management and Budget
PGGI	Plant Genetics and Germplasm Institute, BARC
PI	Plant Inventory
PIO	Plant Introduction Office
PRC	People's Republic of China
PTL	Plant Taxonomy Laboratory
PVPA	Plant Variety Protection Act
RPIS	Regional Plant Introduction Station
S&E	Science and Education, USDA
SAES	State Agricultural Experiment Station
SCS	Soil Conservation Service, USDA
SEA	Science and Education Administration, USDA

SECO	Science and Education Coordination Office, S&E, USDA
SY	Scientist Year
UAB	National Agricultural Research and Extension Users Advisory Board
USDA	United States Department of Agriculture

EXECUTIVE SUMMARY

Crop productivity is essential to the economic and political well-being of this country. Improvements in crop productivity are dependent upon a strong base of agricultural research and education. Of specific importance are those areas of research which combine to provide the basis for the genetic improvement of important plant species. The foundation of that continuum of activities is the National Plant Germplasm System (NPGS). In the United States, responsibility for the collection, preservation, evaluation, and distribution of a broad array of germplasm and the awareness of the needs of researchers for introduced germplasm rests with the NPGS, a coordinated network of scientists from private, State, and Federal sectors of the agricultural research community.

The NPGS currently maintains about 500,000 accessions of germplasm in the form of seed and vegetatively propagated stocks. This wide array of genetic diversity is available without charge to any bona fide plant scientist in the United States, and it is also exchanged with countries around the world.

In an effort to strengthen the NPGS, generally, and to respond to specific concerns raised in reports from the General Accounting Office (GAO) and the National Plant Germplasm Committee (NPGC), the Director of Science and Education approved, in February of 1981, the formation of a Germplasm Task Force, and an appropriate Steering Committee, to formulate a long-range plan (LRP) for the NPGS. This document includes the three primary reports generated by the Task Force: I. Current Status (1980), II. Strengths and Weaknesses, and III. Long-Range Plan (1983-1997).

Current Status (1980)

The NPGS is a rather simple system composed of working, management, and advisory components. The activities of this system form a continuum from the time germplasm is acquired (through introduction, exploration, or from breeding programs within the system), through the maintenance and evaluation of the germplasm, and on through germplasm enhancement efforts and its ultimate benefits to the user community.

The major working components of the system are (1) the Plant Introduction Office (PIO), (2) the "working" collections located at one of four regional plant introduction stations (RPIS's) or with other curators (who handle such major crops as small grains, soybeans, and potatoes), (3) the long-term or "base" collections located at the National Seed Storage Laboratory (NSSL), and (4) the user community. Another critical component (5) which supports the system is an information-management system which is being developed by the Germplasm Resources Information Project (GRIP). When implemented, this information system will impact upon all working components of the NPGS.

The lead role in managing the NPGS is handled by the Agricultural Research Service (ARS), while much of the user community, and some curators, are in the State and private sectors. The Assistant to the Deputy Administrator for Germplasm (ARS) has the primary coordinating position for the NPGS. Those workers at State agricultural experiment stations may be funded by formula Federal funds (primarily Hatch) distributed by Cooperative State Research Service (CSRS), by State appropriations, by CSRS-administered special grants, by other trust or gift funding sources, or by ARS-administered cooperative agreements.

The advisory components play a major role in the NPGS. Most visible among these groups is the National Plant Genetic Resources Board (NPGRB), which offers policy advice directly to the Secretary of Agriculture. The NPGC offers policy advice to Federal and State administrators and provides technical guidance to the NSSL. Major sources of technical advice are the regional technical committees and the crop advisory committees (CAC's).

Strengths and Weaknesses

An effective long-range plan must attempt to capitalize on existing strengths and provide ways by which weaknesses can be corrected. The strengths and weaknesses identified herein may be summarized as follows:

Working Components

A. Plant Introduction

Strengths

- Procedure in existence
- Recognized need
- Strong exchange system
- Availability of genetic diversity

Weaknesses

- No apparent strategy
- Slow to react
- Lack of trained collectors
- Too few collecting trips
- Limited by regulation (quarantine)
- Problems identifying requested domestic material

B. Working Collections

Strengths

- Technology exists to have excellent facilities
- Collections within the system are secure
- Recognition of importance
- Heavy use
- Material is readily accessible
- Material is free to users

Weaknesses

Inadequate grow-out procedures
Lack of succession policy for some curators
Inadequate facilities
Insufficient descriptor information
Redundancy among collections
Seed viability not adequately monitored
Curator role poorly defined
Regional perspective of curatorial units
Impact of Plant Variety Protection Act
Omissions of domestic material in most collections
Limited maintenance research
Not all "major" collections have full-time curators

C. Base Collection

Strengths

Effective seed storage
Strong research program
National recognition

Weaknesses

Lack of space
Coordination with working collections
Effects of sample size and storage containers on space needs

D. Users of the NPGS

Strengths

User community is diverse

Weaknesses

Lack of communication
Inefficient use of germplasm collections
Insufficient germplasm enhancement efforts
Genetic vulnerability not adequately assessed
Insufficient feedback from users

E. Information Management

Strengths

Information-management system is being implemented
Data are being processed

Weaknesses

Data not perceived as a system resource

Lack of perception of potentials of information management
Lack of descriptor information

Management Components

Strengths

Commitment of managers and operators of NPGS

Weaknesses

Unclear lines of authority
Autonomy of State programs
Curators lack technical guidance
Inadequate recognition of service activities
Lack of accountability

Advisory Components

Strengths

Creation of CAC's
Participation increases commitment

Weaknesses

Incomplete representation on key NPGS committees
Committee roles are poorly defined

Long-Range Plan (1983-97)

The first portion of this report presents discussion and recommendations intended to either correct operational and/or managerial flaws or to provide mechanisms to minimize the occurrence of such flaws. The second portion of the report addresses the budgetary needs of the system. Some of the primary thrusts which this document is intended to convey are to:

- (1) Clearly define roles within the NPGS and, thus, minimize opportunities for line/staff, State/Federal, or other conflicts.
- (2) Greatly improve communication within the NPGS.
- (3) Provide rather specific recommendations in some areas, especially some of those being addressed by the GAO.

- (4) Provide mechanisms to assure continued visibility of the germplasm program.
- (5) Recognize the continuum of activities within the NPGS and the importance of tight control and accountability in activities such as maintenance and evaluation; whereas activities such as germplasm enhancement and conservation of genetic diversity are more creative activities which demand less control.

Recommendations

A. Working Components

The current system of reviewing proposals for ARS support of exploration (first within regions and then nationally) has probably worked well as a system of review, but the associated concept of funding by regions is without justification. Acquisition of plant germplasm is a national responsibility requiring national attention.

- Rec. A-1--Funding for ARS-supported plant explorations will be budgeted through the Plant Exploration Office, which will be part of the Economic Botany Laboratory (EBL).
- Rec. A-2--Proposals for ARS funding of plant explorations will be solicited and reviewed by a new committee: the National Plant Exploration Committee (NPEC).
- Rec. A-3--Higher Education (HE) funded followships and/or strengthening grants will be utilized to satisfy training needs.

The PIO, the working collections, the NSSL, and the user community must interact smoothly and effectively if the NPGS is to function to

its full potential. this interaction can be facilitated by the establishment of clearly defined, widely understood rules and relationships.

- Rec. A-4--The working collections will provide the primary interface with the user community.
- Rec. A-5--Regional plant introduction stations will eliminate duplications which exist between their collections. Working collections will include foreign acquisitions, domestic cultivars, and some advanced breeding lines.
- Rec. A-6--Working collections will include foreign acquisitions, wild relatives, and domestic cultivars, plus some advanced breeding lines.
- Rec. A-7--All accessions in working collections will also be cataloged and maintained at NSSL.

The size and/or complexitiy of some collections is such that they can best be handled separately from the RPIS's--potatoes and small grains are examples. These collections have individual curators, but they are an integrated part of the NPGS. Collections of a few other major crops are somewhat on the periphery of the NPGS. Specific recommendations for certain crops should serve as guidelines (to CAC's and the NPGC) for comparable situations which will most likely arise.

- Rec. A-8--One individual will have primary curatorial responsibilities for all collections of a given crop.
- Rec. A-9--A full-time curatorial position will be established for the soybean collection.

- Rec. A-10--One individual will be designated as a coordinator of the three cotton collections and planning will be undertaken to create a full-time curatorial position for cotton germplasm.
- Rec. A-11--Planning will be undertaken to create a full-time curatorial position for peanut germplasm.
- Rec. A-12--The sorghum CAC will closely examine the overall curatorial needs for sorghum.

The curators of the working collections are at the very heart of the NPGS. Their role must be clearly defined and the value of their contribution must be recognized and rewarded.

- Rec. A-13--Individuals assuming curatorial responsibilities (and responsible administrators) will enter into agreements of responsibility as outlined in the "Curator Role."
- Rec. A-14--The ARS Administrator will activate a task group with a charge that they recommend review procedures whereby those professionals with primarily management and/or service responsibilities can receive greater rewards and support.

While recognizing the unique characteristics of individual collections, there is a need for policy guidelines governing replenishment (grow-out) procedures and the monitoring of seed viability. The recommendations which follow are especially applicable to the larger working collections.

- Rec. A-15--Viability of seed stocks in working collections must be monitored to assure reasonably high germination for the period of the replenishment cycle.

- Rec. A-16--Accessions will be replenished on a regular schedule, with complete blocks of a collection being grown in a given year.
- Rec. A-17--The size of increase plots will be determined by the number of plants needed to maintain genetic integrity and by anticipated needs and costs.
- Rec. A-18--The replenishment schedule will be communicated to the user community.
- Rec. A-19--Technical decisions relating to the collections will be dependent upon consultation with the appropriate CAC and national technical advisor (NTA).
- Rec. A-20--Working collections will be responsible for all grow-outs, including those required by NSSL.

The security of the NPGS is dependent upon the policies and management associated with NSSL. The projected use of this facility will soon require expansion. There is an immediate need, however, for careful examination of several policies associated with the operation of this facility.

- Rec. A-21--The NPGC will provide recommendations for optimal use of space within the NSSL.
- Rec. A-22--The NPGC will solicit inputs from the Director of NSSL and from all identifiable curators in an attempt to reduce the number of seeds required in each NSSL storage sample.
- Rec. A-23--New accessions will enter the NPGS by being sent either to the PIO (foreign) or to the appropriate working collection (domestic)--<u>they will not be entered directly through NSSL</u>.

- Rec. A-24--NSSL will (either in-house or through contracts) assume all germination testing responsibilities for the NPGS.

Improved communication is a major need of the NPGS. No single communication instrument is likely to meet this need so it is imperative that all elements of the NPGS have a continuing motivation to search for effective means of <u>two-way</u> communication. The recommendations which follow indicate a few communication devices designed to meet some obvious needs--more will be needed.

- Rec. A-25--Curators of all working collections and the PIO will generate semiannual newsletters for mailing to their respective clientele.
- Rec. A-26--Curators will take maximum opportunity to include reports in commodity newsletters.
- Rec. A-27--A meeting of a new work group--the Association of Plant Germplasm Curators (APGC)--will be held annually.
- Rec. A-28--The Data Base Manager (DBM) will utilize all practical means to communicate the availability and potentialities of the Data Base Management System (DBMS).

Successful implementation of the DBMS is of critical importance to the NPGS. Some of the pending decisions relative to that implementation are both difficult and important. Since these decisions are being addressed by a broadly based GRIP Coordinating Committee, specific recommendations relative to the DBMS implementation are not included in this report.

- Rec. A-29--The DMBS will be implemented early in FY 1983, with sufficient financial support to assure the success of this critical element of the NPGS.

B. Management Components

A management system will probably be judged effective if the interrelationships between decisions are visible and coordinated and if it is readily apparent what kinds of decisions are made at what levels and upon what criteria.

- Rec. B-1--The ARS Administrator will reaffirm the leadership role of the Assistant to the Deputy Administrator for Germplasm and his involvement in budget development, program planning and review, and monitoring.
- Rec. B-2--Funding and coordination of germplasm evaluation will be through ARS. Cooperative agreements will be utilized to fund non-Federal projects.
- Rec. B-3--Germplasm enhancement efforts will receive support through both ARS and CSRS.

An interagency problem affecting the NPGS is the need for better coordination between ARS and APHIS in discussing such issues as central facilities, systematic quarantine procedures for crops such as corn and sorghum, and direct quarantine and indexing by clonal repositories.

- Rec. B-4--The Science and Education Coordination Office (SECO) will coordinate the development of an ARS/APHIS Germplasm Oversight Committee.

C. Advisory Components

The NPGRB advises the Secretary of Agriculture and it can play a vital role in providing important policy advice at the highest levels of USDA management. The NPGRB cannot hope to operate with full effectiveness unless it receives adequate staff support.

- Rec. C-1--The NPGRB merits and will receive at least half-time support from a dedicated staff position. This primary support position will provide secretariat services to the NPGRB and will have access to sufficient funding to support NPGRB activities.

CAC's are formed when a crop is deemed to have sufficient need by the NPGRB and when the scientists associated with that crop show sufficient organization and interest to select such a committee. While he CAC's have proven to be an especially valuable addition to the NPGS, they are limited by time and resources from providing the immediate responses needed to asssure effective technical guidance on a continuing basis.

- Rec. C-2--An NTA will be designated, within ARS, for each crop having a CAC.

It is of critical importance that existing CAC's continue to operate effectively and that new CAC's come into operation as needs arise.

- Rec. C-3--Although "owned" by their respective user communities, the CAC's will be facilitated by a carefully selected invidiaul operating under the direct supervision of the Assistant to the Deputy Administrator for Germplasm.

D. Facilities

The most immediately needed facility in the NPGS is a new building to house the Small Grains Collection. Other identified needs are for additional space at NSSL and a facility to consolidate germplasm activities at Beltsville, MD.

- Rec. D-1--A new facility will be built at Aberdeen, ID, which will house the staff associated with the Small Grain Collection and provide space and equipment to process, evaluate, maintain, and manage the collection.
- Rec. D-2--A "Germplasm Center," housing the U.S. Plant Introduction (quarantine) Station, the PIO, the Data Base Management Unit, the EBL, and the Plant Taxonomy Laboratory (PTL) will be constructed at Beltsville, MD.
- Rec. D-3--Additional space which is needed for the NSSL will be gained by expanding the present facility.

E. Implementation

While this document presents a plan to address these needs and problems over a 15-year period, it is unlikely that the NPGS will maintain this level of visibility for that time period. It is important, therefore, that there be a mechanism to assure the continued consideration of this plan.

- Rec. E-1--There will be an annual meeting (in January) with the Assistant Secretary for S&E to discuss the budgetary status of the NPGS. This meeting will be arranged by the Executive Secretary of the NPGRB and those attending will include (1) the Vice-chairman of the NPGRB, (2) the Chairman of the NPGC, (3) the Assistant to the Deputy Administrator for Germplasm, and (4) the Executive Secretary of the NPGRB.

Budget Requirements

Of the eight "key objectives" utilized in the recurring portion of the budget projections, the first five (acquisition, maintenance, evaluation, germplasm

enhancement, and research on the conservation of genetic diversity) form the basic continuum of NPGS activities. The last three (information management, monitoring genetic vulnerability, and training) are areas essential to the support of the system.

The planning considerations upon which the budget requirements were determined are as follows:

- (1) One method by which current managers can "institutionalize" their current level of interest in the NPGS is to recognize that this is, indeed, a priority area which is far from the budgetary base needed to fulfill its mission.
- (2) Sufficient funding must be made available to meet immediate exploration needs, especially in those habitats where man's encroachment may offer an immediate threat to native germplasm.
- (3) The long-range effectiveness of the NPGS will depend upon the more immediate strengthening of the maintenance and evaluation portions of the NPGS continuum, plus the information management and training components which support the system.
- (4) While the system does monitor genetic vulnerability, a budget base must be established to support these activities.
- (5) Germplasm enhancement, research on conservation of genetic diversity, and acquisition are activities of immediate importance, but it is especially important that their long-range value be recognized. Support of these activities becomes increasingly important as a followup to earlier expenditures on maintenance and evaluation.

- (6) It is important to recognize which components of the State/Federal (and sometimes private) partnership can best perform these key objectives, and through which agency they can most effectively be funded.
- (7) The NPGS has certain minimal facility needs which must be met to support the expanded system.

Total budget requirements for the period 1983-97 are summarized in table A.

Table A. Plant Germplasm--Total Required Science and Education Increases 1/ ($million), FY's 1983-97.

	Fiscal Year															
FUNDING REQUIREMENT	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Total
TOTAL RECURRING	8.0	6.0	5.0	4.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	36.0
FACILITIES ASSESSMENT, CONSTRUCTION, PROCUREMENT	2.0	1.5	7.3	1.3	1.9	1.5	.6	2.9	2.7	--	--	--	--	--	--	21.7
TOTALS	10.0	7.5	12.3	5.3	3.9	3.5	1.6	3.9	3.7	1.0	1.0	1.0	1.0	1.0	1.0	57.7

1/ All projections in terms of 1981 dollars.

THE NATIONAL PLANT GERMPLASM SYSTEM

I. CURRENT STATUS (1980)

CONTENTS

List of Figures

List of Tables

List of Appendices

PREFACE

This report represents the initial phase in the development of a long-range plan for the National Plant Germplasm System (NPGS). A meaningful long-range plan must be developed to capitalize on the strengths of the current system and compensate for its weaknesses. This report synthesizes information from a number of sources to provide an overview of the current status of the NPGS. The strengths and weaknesses of the system are assessed in a second report and are not discussed herein.

NOTE: This report does not reflect changes resulting from the 1981 reorganization within USDA, Science and Education, because of the intent to indicate the status of the NPGS in 1980.

MISSION STATEMENT

In order to provide genetic diversity to increase crop productivity and reduce genetic vulnerability in future food and agriculture development, not only in the United States, but for the entire world; it is the mission of the National Plant Germplasm System (NPGS) to acquire, maintain, evaluate, and make readily accessible to crop breeders and other plant scientists as wide as possible a range of genetic diversity in the form of seed and clonal germplasm of our crops and potential new crops.

Section I.

INTRODUCTION

Most of the plants from which the United States derives its food and fiber were introduced from other countries. The list of economically important native plants is very short and includes such crop plants as sunflowers, cranberries, blueberries, strawberries, pecans, hops, range grasses, conifers, and hardwoods.

In precolonial and colonial times, early explorers and colonists who settled on Eastern shores were faced with the almost total lack of native food and fiber crops. Indians used many wild plants, but Indian corn (maize), beans, squash, and tobacco were the only crops found to be of much use.

With the exception of tobacco, all these crops were brought into the United States from Mexico hundreds of years before by early Indian tribes. Corn was by far the most important food crop. Incoming colonists were cautioned to bring seeds of most crops with them. This form of plant introduction continues up to the present.

Because of a dearth of native crop germplasm and a shallow base of primitive varieties, modern agriculture in the United States depends on a coordinated system to introduce, evaluate, and maintain the germplasm obtained elsewhere. No single entity can be expected to provide the germplasm required by the array of scientists working even within a single crop. Therefore, research needs require an efficiently organized effort to assure that Federal, State and local institutions, and private industry can obtain needed plant germplasm.

There are large gaps in the genetic diversity base of some crops, particularly the wild species and primitive varieties that may contain genes for disease and insect resistance and other desirable traits. Although found in many areas of

the world, these sources of diversity are rapidly being depleted, displaced, or abandoned. Once lost, these sources will never again be available to mankind.

The nature of collecting and assembling genetic resources requires international collaboration. In the United States, the preservation, evaluation, and distribution of this broad array of germplasm and the awareness of the needs of researchers for introduced germplasm rests with the National Plant Germplasm System (NPGS), a coordinated network of scientists from the private, State, and Federal sectors of the agricultural research community.

In all, the NPGS now maintains about 500,000 accessions of germplasm in the form of seed and vegetatively propagated stocks. These accessions are primarily cultivars and unimproved germplasm from foreign sources. A few working collections, and the National Seed Storage Laboratory (NSSL), also maintain some domestic breeding lines and cultivars. Any of this wide array of genetic diversity is available without charge to any bona fide plant scientist in the United States. In addition, material in the NPGS is exchanged with countries around the world for germplasm needed by our scientists. In providing germplasm to users, domestic or foreign, only a portion of a given accession leaves the system. A given accession is never exhausted--it is maintained and increased as necessary.

New accessions of germplasm are added to the system at the rate of 7,000 to 15,000 per year. Approximately 70 to 80 percent of these come through exchange with other countries; the rest are acquired through direct collecting expeditions, foreign and domestic, and from the user community.

Basically, the NPGS is well designed to provide, on a continuing, long-term basis, the plant genetic diversity needed by the public and private plant scientists and, ultimately and most importantly, the farmers of the Nation

for the purpose of improving productivity of crops and minimizing the vulnerability of those crops to biological and environmental stresses. This so-called genetic vulnerability of crops comes into play when an out-of-the-ordinary range of stresses from diseases, insects, drought, or temperature extremes exceeds the crop's range of tolerance or resistance to such factors. The results can vary all the way from noticeable yield reduction in localized areas to crop failures over very large areas.

Protection from crop losses through control of biological and environmental stresses is far more difficult and costly than through increased genetic diversity among varieties of a given crop. Therefore, the objective is to broaden the genetic diversity of a crop throughout its production area by having that production come from an array of varieties, all productive but each different from the others in terms of its range of tolerance to one or more potential stresses. This can reduce the likelihood of epidemic losses.

Section II.

ORGANIZATIONAL STRUCTURE

The NPGS is a cooperative national effort involving Federal, State, and private programs. It is also a major component of an international plant germplasm network and, as such, coordinates its efforts with the International Board for Plant Genetic Resources (IBPGR).

The major working components of the system are: (1) the Plant Introduction Office (PIO); (2) the "working" collections located either at one of four regional plant introduction stations (RPIS's) or with curators (who handle such major crops as wheat, oats, barley, rice, soybeans, and tobacco, as well as Genetic Stock Collections); (3) the long-term or "base" collections located at the NSSL; and (4) the user community, a broad array of scientists, educators, and commercial concerns involved in prebreeding (transferring desirable genetic traits into phenotypes which can be more readily utilized in varietal development) and varietal development as well as numerous other research areas. Another critical component of the system (5) is an information-management system, which has just been developed by the Germplasm Resources Information Program (GRIP). When implemented, this information system will impact upon all working components of the NPGS.

Management of the diffuse system is largely delegated through USDA-SEA with the primary coordinating position being the Assistant to the Deputy Administrator for Germplasm within USDA-SEA-AR. Prior to 1972, the PIO and the four RPIS's, four Federal plant introduction stations (two have since been closed), and NSSL were administered through USDA-ARS New Crops Research Branch, and other major

collections through the specific branch dealing with that commodity. Plant introduction of all crops, however, was the responsibility of the New Crops Research Branch. Since 1972, the system has been subject to the regionalized administrative structure of USDA-SEA-AR. Those State or private workers involved as curators or users are administered independently.

The NPGS also includes a number of advisory components. The National Plant Genetic Resources Board (NPGRB) is a policy advisory group which advises the Secretary of Agriculture on matters relating to germplasm. The National Plant Germplasm Committee (NPGC) took the place of the New Crops Committee, after the 1972 reorganization, and it provides advice and coordination to the NPGS, primarily through AR and State agricultural experiment station (SAES) administrations. It also provides technical advice to the NSSL. The AR Plant Germplasm Coordinating Committee advises the Administrator on operational matters especially AR-funded explorations. A regional technical committee, with an SAES director as its administrative advisor, provides advice to each RPIS. Crop advisory committees (CAC's) are now in existence for 10 major commodities. They provide technical advice to the respective curators, the GRIP team developing the information-management system, NPGRB, and NPGC.

Figures 1 and 2 and table 1 provide a visual summary of the working, management, and advisory components, respectively, of the NPGS. Some of these components are described in more detail within this report.

Figure 1. Working Components of NPGS

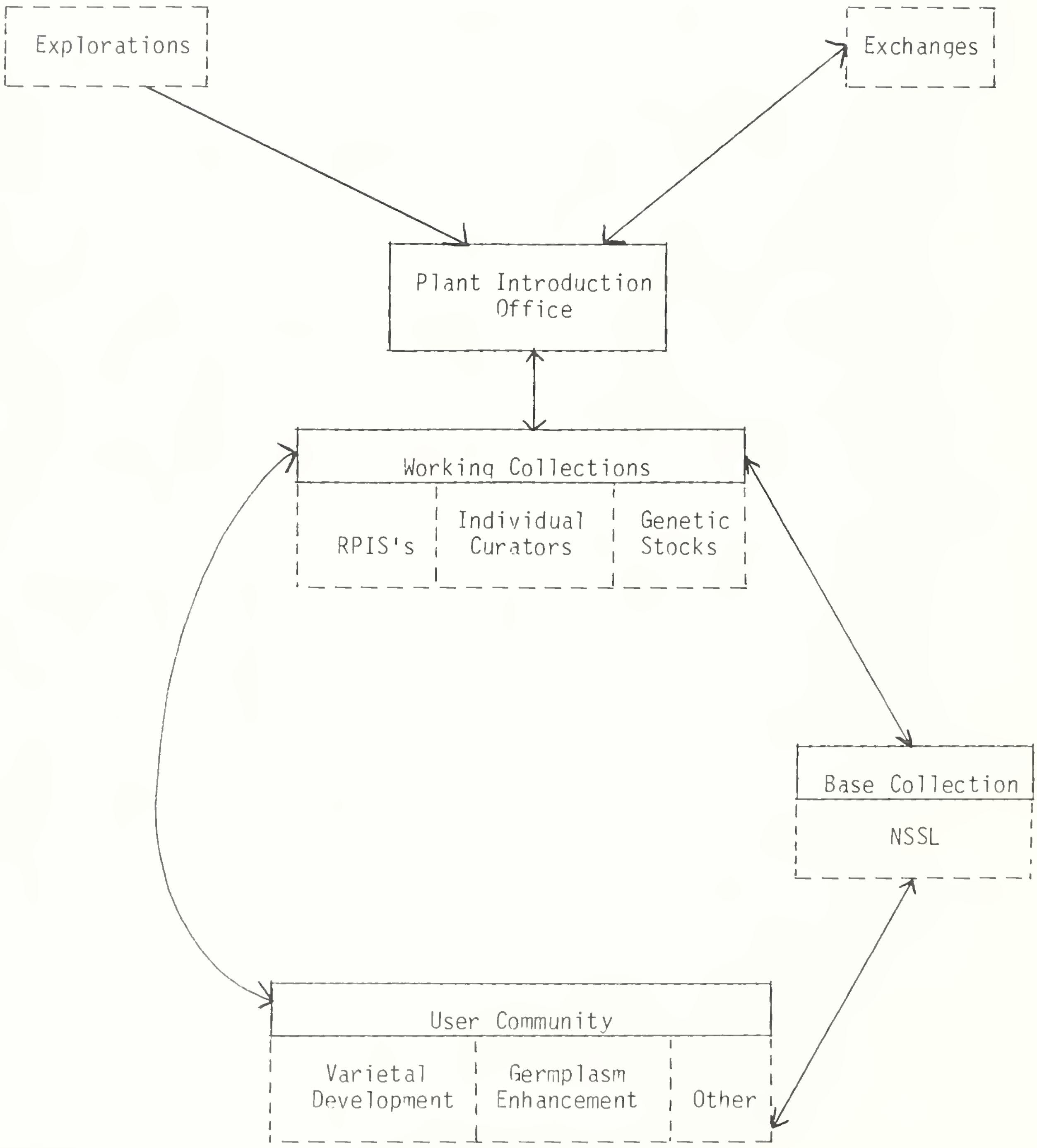


Figure 2. Management Components of NPGS

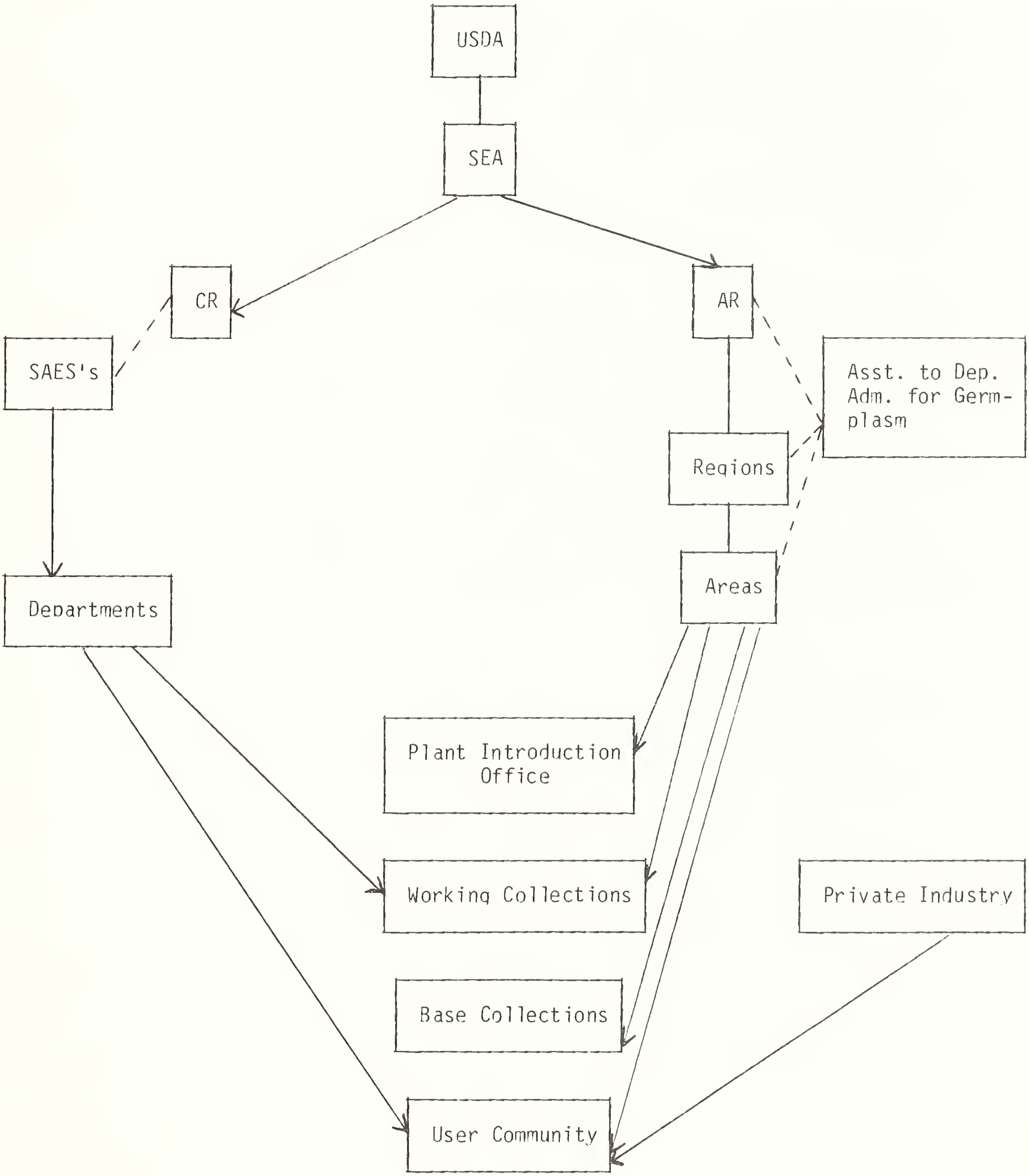


Table I. Advisory Components of NPGS

Advisory Component	Kind of Advice	Advice to Whom
National Plant Genetics Resources Board	Policy	Secretary of Agriculture
National Plant Germplasm Committee	Policy and Technical	SAES Administrators AR Administrators Curator-NSSL Curators-Clonal repositories
AR Plant Germplasm Coordinating Committee	Policy and Technical	AR Administrators
Regional Technical Committees	Technical (Policy)	RPIS's (NPGC) (SAES's)
Crop Advisory Committees	Technical	Specific Working Collection Curators GRIP Team NPGRB NPGC

Section III.

WORKING COMPONENTS

The principal stations or laboratories within the NPGS are listed in table 2. The NSSL located at Fort Collins, Colorado, provides long-term storage for all crop species. Its function is preservation as opposed to being a working collection.

The Germplasm Resources Laboratory (GRL) is a SEA-AR administrative unit of the Plant Genetics and Germplasm Institute (PGGI) at the Beltsville Agricultural Research Center (BARC), Beltsville, Maryland. Four major components of the NPGS are a part of this laboratory, the PIO, the USDA Small Grains Collection, the USDA Rice Collection, and the SEA-AR plant introduction station located at Glenn Dale, Maryland. Five additional laboratories are administrative units of PGGI. The Plant Taxonomy and Economic Botany Laboratories (EBL) serve the NPGS at the working level. Research programs within the other three laboratories fall into the user category.

The PIO is the focal point for the acquisition and exchange of plant germplasm. Assignment of a PI (plant inventory) number and initial documentation and distribution are functions of this office, but no collections are maintained there. Any plant materials provided to foreign scientists are obtained and forwarded by the PIO.

The USDA Small Grains Collection is the largest working collection with holdings of 82,000 wheat, barley, oats, rye, and *Aegilops* accessions. It is one of the few major elements of the NPGS which maintains and distributes domestic lines and cultivars as well as materials currently under the PI system. The USDA Rice Collection of approximately 15,000 accessions is also maintained within the GRL.

The SEA-AR plant introduction station at Glenn Dale also serves as the Plant Quarantine Facility of the Animal and Plant Health Inspection Service (APHIS). Maintenance and distribution of pome and stone fruits and woody ornamentals are handled by SEA, while virus indexing and quarantine handling of these and other crop categories are the responsibility of APHIS.

One additional SEA-AR plant introduction station is located at Miami, Florida. Maintenance and distribution of tropical and subtropical species are handled at this location. Former Federal plant introduction stations at Chico, California, and Savannah, Georgia, are no longer in operation.

The four State/Federal RPIS's are located at Geneva, New York; Experiment, Georgia; Ames, Iowa; and Pullman, Washington. Most of the crop and noncrop species are maintained, evaluated, and distributed from these stations. The collections are comprised primarily of accessions under the PI numbering system and species are assigned to a specific station. Several crops, however, are not represented at the RPIS, but rather are held by one of the other units mentioned or by curators located throughout the United States.

Also a State/Federal interregional station is located at Sturgeon Bay, Wisconsin. The Potato Introduction Station handles only potatoes and related species.

A clonal repository (see appendix) has been established and dedicated at Corvallis, Oregon, and one is under construction at Davis, California, with curators hired for each location. The Mayaguez Institute of Tropical Agriculture (MITA) at Mayaguez, Puerto Rico, has responsibility for maintaining some tropical germplasm. The Soil Conservation Service (SCS) also operates and/or funds 20 plant materials centers which maintain and evaluate approximately 16,000 domestic and

foreign plant collections (see appendix). Several curators and cooperators throughout the United States, Puerto Rico, and the Virgin Islands maintain additional collections of germplasm.

The number of accessions held and the samples distributed in 1980 are given in table 3 for the principal stations and laboratories within the NPGS.

Table 2. National Plant Germplasm System: Principal Stations or Laboratories Responsible for Introduction, Maintenance, and Distribution of Plant Germplasm

Station or laboratory	Name and address	Examples of responsibilities for major collections	Remarks
National Seed Storage Laboratory (NSSL)	Louis N. Bass National Seed Storage Lab. Colorado State University Fort Collins, CO 80521	Gene bank collections of seed crops and their wild relatives	Long-term storage
Germplasm Resources Laboratory (GRL)	H. E. Waterworth, Chief Germplasm Resources Laboratory Building 001, Room 324 BARC-West Beltsville, MD 20705	See below.	Administrative unit including Plant Introduction Office, USDA Small Grains Collection, USDA Rice Collection, SEA Plant Introduction Station (at Glenn Dale, MD), and related research.
Plant Introduction Office (PIO)	George A. White Plant Introduction Officer Building 001, Room 322 BARC-West Beltsville, MD 20705	None	National focal point for introduction, documentation, initial distribution, and foreign exchange of plant germplasm.
USDA Small Grains Collection	D. H. Smith, Jr. USDA Small Grains Collection Building 046, BARC-West Beltsville, MD 20705	Collections of wheat, oats, barley, and rye.	
USDA Rice Collection	A. J. Oakes Building 001, Room 338 BARC-West Beltsville, MD 20705	Rice	
SEA Plant Introduction Station	H. E. Waterworth U.S. Plant Introduction Station P.O. Box 88 Glenn Dale, MD 20769	Pome and stone fruits and woody ornamentals.	Distributes certified pest-free introductions consisting of prohibited and postentry quarantine categories of fruits, woody ornamentals, and certain vegetables.

Table 2. National Plant Germplasm System--Continued

Station or laboratory	Name and address	Examples of responsibilities for major collections	Remarks
SEA Plant Introduction Station	Paul K. Soderholm Subtropical Horticultural Research Station 13601 Old Cutler Road Miami, FL 33158	Tropical & subtropical species including coffee, mangoes, and cacao	Research on mango, avacado, & other tropical fruits.
Northeastern Regional Plant Introduction Station (NE-9)	Desmond D. Dolan N.Y. State Agric. Expt. Sta. Regional Plant Intro. Station Geneva, NY 14456	Perennial clover, onion, pea, broccoli, timothy	Operating through Regional Research Project, NE-9, 12 States, SEA, FS, & SCS participating.
Southern Regional Plant Introduction Station (S-9)	G. R. Lovell Regional Plant Intro. Sta. Experiment, GA 30212	Cantaloupe, cowpea, millet, peanut, sorghum, pepper	Operating through Regional Research Project, S-9, 14 States, SEA & SCS participating.
North Central Regional Plant Introduction Station (NC-7)	Willis H. Skrdla Regional Plant Intro. Sta. Iowa State University Ames, IA 50011	Alfalfa, corn, sweet clover, beets, tomato, cucumber	Operating through Regional Research Project, NC-7, 13 States, SEA & SCS participating.
Western Regional Plant Introduction Station (W-6)	S. M. Dietz Regional Plant Intro. Sta. Room 59, Johnson Hall Washington State University Pullman, WA 99163	Bean, cabbage, fescue, wheat grasses, lentils, lettuce, safflower, chickpeas	Operating through Regional Research Project W-6, 13 States, SEA, SCS, FS, & BLM participating.
Interregional Potato Introduction Laboratory (IR-1)	Robert E. Hanneman, Jr. Interregional Potato Introduction Station Sturgeon Bay, WI 54235	<u>Solanum tuberosum</u> and <u>Solanum spp.</u>	Operating through Interregional Project 1, SAES & SEA in four regions participating.

Table 2. National Plant Germplasm System--Continued

Station or laboratory	Name and address	Examples of responsibilities for major collections	Remarks
Northwest Clonal Repository	Otto L. Jahn Northwest Plant Germplasm Repository 33447 Peoria Road Oregon State University Corvallis, OR 97330	Pears, filberts, small fruits, hops, and mints	
Fruit and Nut Germplasm Repository	D. E. Parfitt University of California Davis, CA 95616	Grapes, stonefruits, nuts	Not yet operational

Table 3. Number of Accesions Held and Samples Distributed by Various Units within the National Plant Germplasm System in 1980

Station or Laboratory	Total accessions held	Samples Distributed
National Seed Storage Laboratory	117,742	1,730
Germplasm Resources Laboratory		
Plant Introduction Office	-	106,324*
USDA Small Grains Collection	82,295	99,000
USDA Rice Collection	15,000	765
SEA Plant Introduction Station (Glenn Dale, MD)	6,200	2,565
SEA Plant Introduction Station (Miami, FL)	5,000	2,984
Northeastern Regional Plant Introduction Station	20,000	7,749
Southern Regional Plant Introduction Station	40,000	18,757
North Central Regional Plant Introduction Station	22,000	20,815
Western Regional Plant Introduction Station	28,000	17,714
Interregional Potato Introduction Station	4,000	4,389

*Part of this total includes the portion of other distributions destined for foreign locations.

A. FUNCTIONS

1. Plant Introduction

Colonists arriving in the "New World" quickly recognized the need to bring various crop seeds from their homelands. This need persisted, and in 1898, a formalized plant introduction program was initiated by USDA. Today, the acquisition of plant germplasm for crop research remains a vital and essential element of United States agriculture. The focal point for this acquisition effort is the PIO, whose program is administered through the GRL, within the PGGI at Beltsville, Maryland.

Through extensive worldwide contacts, germplasm is freely exchanged between the United States and any interested country. This is the predominant source of foreign plant germplasm that enters the NPGS. While the bulk of exchanges are handled by the PIO, scientist-to-scientist contacts also result in significant movement of plant germplasm. Specific foreign sources of plant acquisitions may also be obtained from scientists, research and germplasm organizations, special research projects such as Public Law 480, binational agreements, and occasionally voluntary donations of United States citizens who travel abroad. Considerable plant germplasm, often from areas of high genetic erosion, is also obtained through explorations sponsored by IBPGR. These collections are maintained in the United States as base collections at the NSSL.

Formal plant explorations usually focus on particular crop species identified as needing additional diversity or on endangered germplasm. Proposals for SEA-AR support of both foreign and domestic explorations surface through a regional review arrangement. Proposals are submitted to the appropriate RPIS coordinator and are subsequently reviewed and given priority by the respective regional technical Committee. Finally, proposals from all four regions are reviewed

and ranked by the SEA-AR Plant Germplasm Committee. Those of highest priority are funded within SEA-AR budget constraints. Collected items become the property of the NPGS and are incorporated into germplasm collections after PI documentation. Once an exploration is approved, the PIO provides support relative to foreign contacts, special clearances, quarantine requirements, special supplies, etc. International organizations, especially IBPGR, also sponsor explorations that sometimes involve United States crop specialists. Usually such materials are divided between two or more germplasm collections.

Foreign introductions that go into NPGS are documented with PI numbers by the PIO. Information on source, origin, identifier designations, cultivar name, locality, local name and usage, and descriptive details is documented and each accession assigned a PI number. The material is then sent to the appropriate curator and/or scientist. The majority of accessions within the NPGS are materials received from foreign sources and identified by a PI number. In 1980, 15,000 PI's were incorporated into NPGS.

Most countries have phytosanitary requirements which vary widely to protect against possible introduction of injurious exotic pests. The primary and preferred flow channel for introduced and foreign exchanged items is through the U.S. Plant Germplasm Quarantine Center in Beltsville, Maryland, so that quarantine requirements of the importing countries (including the United States) can be met. The Plant Germplasm Quarantine Center is jointly operated by APHIS and the PIO. APHIS has responsibility for regulation and SEA-AR for the handling of germplasm. Quarantine requirements of United States plant imports vary greatly depending on the crop and the source country. Some materials are prohibited and may enter only via APHIS/SEA-AR. For other restricted crops, individual scientists may obtain permits to receive material. Systematic

arrangements for handling the quarantine requirements of imported germplasm of crops such as rice, wheat, sugarcane, tree fruits, and Irish and sweet potatoes are operative. No such arrangements exist for restricted introductions of corn, sorghum, certain millets, and related species. Therefore, importation of germplasm of these crops from some countries is restricted. The PIO acts as a liaison between APHIS and United States scientists to expedite the movement of plant germplasm into NPGS and individual research programs.

Plant germplasm from domestic sources is handled in various ways. All materials from SEA-AR-funded domestic explorations are assigned PI numbers and distributed to appropriate curators. A few collections such as the small grains, rice, and soybeans include domestic cultivars, breeding lines, genetic stocks, and other items. Few of these domestic materials are assigned PI numbers, but all are components of NPGS. NSSL holds large numbers of domestic materials including United States cultivars, _Datura_ species, breeder lines, international base collections, and other materials under NSSL serial numbers or as uncataloged items. Individuals sometimes donate unsolicited items to PIO. As appropriate, these are incorporated into NPGS.

The exchange portion of the PIO program compliments and facilitates the acquisition efforts. Plant germplasm is obtained by PIO from RPIS, curators and scientists, and commercial firms in response to foreign requests. In 1980, 106,000 accessions of plant materials were sent to foreign cooperators.

The NPGS could not accomplish its mission without many strong international links. Seventy to eighty percent of new plant introductions are provided through a worldwide plant exchange program. Direct plant explorations, which

account for the remaining 20 to 30 percent of new introductions, are mostly done in foreign countries with United States scientists and host-country scientists working together and sharing collections.

The world network of research centers for major crops [e.g., International Rice Research Institute (IRRI), Philippines; International Maize and Wheat Improvement Center (CIMMYT), Mexico; and International Potato Center (CIP), Peru] are heavily involved in germplasm acquisition, maintenance, and use. These centers draw heavily upon United States collections and are valuable sources of germplasm for the United States.

The IBPGR, with its supporting Secretariat in FAO, Rome, Italy, serves as a catalyst to promote worldwide activities in the collection, documentation, maintenance, and exchange of germplasm. United States support of, and cooperation with, the IBPGR has been, and will continue to be, mutually rewarding. The United States collections are being used by more and more countries; our NSSL serves as a primary base collection or as a back-up base collection (long-term maintenance) for crops that are important worldwide; and through the increasing development of germplasm systems in other countries, the United States has improved access to germplasm needed in this country.

Our new crops screening programs for anticancer agents and for new sources of seed oils, waxes, gums, proteins, hydrocarbons, fibers, etc., and our narcotics control program continually depend on close working relationships with foreign countries and international organizations.

2. Working Collections

Working collections (active collections) are an assemblage of germplasm (genetic resources) maintained to meet the day-to-day research needs of breeders,

geneticists, pathologists, entomologists, cytologists, agronomists, horticulturalists, and other users who wish to utilize it for research purposes.

The curators of these collections agree to maintain the collections under reasonably good storage conditions and by seed rejuvenation plantings as required, or by protected, well managed plant repositories in the case of clonally propagated species. They maintain a current inventory of accessions in the collection and agree to make reasonable amounts of the germplasm under their care available at no charge to bona fide research scientists and institutions. The curator is not intended to have the option of discarding elements of the collection on his own volition. When changes in program, personnel, physical facilities, or administrative policy place a collection in jeopardy, it is the curator's responsibility to notify appropriate officials within the NPGS.

3. Base Collection (NSSL)

In 1944, the National Research Council of the National Academy of Science (NAS) recommended that the USDA establish a national facility for the preservation of valuable plant germplasm. There is no record available covering the period 1944-49. In 1949, a special subcommittee of the National Coordinating Committee for New Crops was appointed to draw up plans for a national seed storage facility. Through communication with plant breeders and other plant scientists, the subcommittee developed the scope of the need and drew up specifications for a national seed storage facility. In 1956, Congress appropriated $450,000 for construction of NSSL, plus $100,000 per year to operate it. The budget history of the NSSL for the past decade is presented in appendix D.

The NSSL, USDA-SEA-AR, located on the campus of Colorado State University, Fort Collins, Colorado, has been in operation since 1958. The Laboratory maintains

plant germplasm as a base collection for the United States and, through formal and informal cooperation, for the global network of genetic resources centers. Present categories of stocks in storage include basic plant introductions, recently released and obsolete varieties, open-pollinated parental lines and genetic stocks, differential host and virus indicator stocks, and type specimens for future reference.

The seeds held in the NSSL constitute the base collection for the United States NPGS. Base collections are not intended to meet the day-to-day needs of plant breeders and other plant scientists, but rather are reserve stocks to prevent loss of germplasm and erosion of genetic variability. Generally, seed samples in base collections are also held in a working collection and are distributed only when unavailable from some other source.

Samples in base collections are for indefinite storage with regrowing as infrequently as possible to prevent genetic changes through repeated seed increases, but often enough to prevent genetic changes through deterioration or loss of viability.

The present NSSL building is a three-level building. The ground floor contains the equipment room, control room, growth-chamber room, garage-shop, janitor supply room, library-conference room, plant physiology laboratory, and a storeroom. Administrative offices occupy the second level, and the seed storage rooms and the germination laboratory occupy the third floor. The building is constructed of heavily reinforced concrete.

The capacity of the 10 storage rooms is 180,000 one-pint metal cans, which were used initially as containers for the stored seeds. The number of seed samples that can be stored has been expanded by switching to flexible containers that

vary in space occupied by the size and quantity of seeds. The containers of seeds are stored in steel trays placed in steel racks. Any risk of fire is practically eliminated except for the 4 inches of cork insulation on the periphery of the storage rooms. The cork, however, is protected by a half-inch of plaster.

Storage conditions in most of the rooms were maintained initially at about 5 °C and 35 percent relative humidity. The 5 °C temperature was selected as being suitable for safe storage of most kinds of seeds for at least 10 to 15 years. Three rooms, however, were equipped to maintain -12 °C, a temperature suitable for storage of some kinds of seeds for 30 or more years. Based on research findings, the refrigeration system has recently been upgraded so that most of the rooms are presently maintained at -18 to -20 °C. One room is still maintained at 5 °C for those kinds of seeds which cannot be frozen without loss of viability.

At present, more than 117,000 cataloged accessions are in storage and more than 117,000 additional samples are stored in unopened boxes, but not catalogued into the base collection.

In addition to the storage of germplasm, the staff of the NSSL also conducts research on long-term seed storage and related seed germination problems.

Included in appendices C through F are budget and personnel records for the NSSL and a Subcommittee Report from the NPGC entitled "Site Selection and Facility Requirements for the National Seed Storage Laboratory," and a National Seed Storage Laboratory Policy Statement.

4. Users of the NPGS

The largest group of users of the NPGS deals with increasing crop productivity and includes plant breeders, pathologists, entomologists, and some plant physiologists. This group identifies and creates germplasm having resistances to biotic (disease, insects, etc.) and abiotic (drought, winter hardiness, toxic soils, etc.) stresses, and germplasm that may have genes for higher crop productivity (many kernels, many tillers or ears, short stature, etc.). Another group uses the NPGS as the source of research materials and as a primary standard for their studies. This group may intensively study some portion of the germplasm. An example would be a basic researcher comparing barley DNA to mouse DNA. He would receive one or more barley lines from the NPGS for his research and might return to the NPGS for more seed of the same line(s). A third user group studies germplasm methodologies (crop evolution, ecodistribution, chromosome pairing, etc.). A researcher studying tomato evolution might request samples of each tomato species to determine if they can be cross-pollinated.

The first two user groups and many of the third user group are not officially part of what may be called the core (acquisition, maintenance and distribution, evaluation, and now information management) NPGS. Their activities, in general, are not coordinated by members of the core NPGS, but instead are coordinated by their commodity, discipline, and affiliation. Hence, the user community is an extremely diverse group having many different coordinators and policies.

When considering the user group related to crop productivity, a number of points need to be considered. Firstly, the NPGS is a continuum of activities. It should be noted that many of the improved materials acquired by the NPGS (in these collections which include domestic material) come from the crop productivity user group, that they also maintain a number of the the germplasm and cultivar

lines, and that they are often the major evaluators of the germplasm. Plant breeding relies upon careful evaluation of parental lines prior to intermating and thorough evaluation of the resultant progeny.

In order to develop improved cultivars, most breeders rely on intermating the best adapted and highest-yielding lines. While yield is the most important attribute, quality and pest resistance also must be present. Combinations of genes that produce high yield, good resistance to various stresses, and good quality are the result of vigorous selection and are rare. Over 99 percent of all breeding materials are discarded and never released. This breeding philosophy capitalizes on the need to maintain those highly selected combinations of genes. For example, the progeny of a cross between two cultivars both having good quality are much more likely to have good quality than the progeny of a cross between one parent having good quality and one having poor quality. Once such a combination is lost, it is often very difficult to recover.

There are many constraints on the development of new cultivars. With resources that are often limited, breeders must address needs to improve quality, stress resistance, uniformity, and yield. Pests are notorious for changing, often making formerly resistant cultivars susceptible. Quality needs can also change. Higher protein, vitamin, lipid, or enzymatic levels can be required by the end product users. Uniformity is also required for efficient cultural management.

In general, large portions of the germplasm are not used. Those lines that are unadapted or from different quality classes are avoided and used only as a last resort. It is difficult to utilize useful genes in these lines because of the time and selection their use requires in recovering the necessary combination

of useful genes. If a gene from one of these unadapted germplasm sources is incorporated into an agronomically acceptable line, breeders will tend to use that new line rather than finding a different gene in another unadapted source. Hence, the genetic base of the improved cultivars can readily become very narrow and vulnerable despite the breadth of the germplasm system. Breeding constraints tend to increase crop vulnerability. Crop vulnerability by definition relates to the commercially grown crop which is totally comprised of cultivars that were developed by plant breeders.

While increased crop vulnerability can be and often is caused by efficient and successful plant breeding, there are also many areas where crop productivity researchers have deliberately attempted to avoid vulnerability. One example is the careful monitoring of pests by international and national uniform nurseries, trap nurseries, and other surveys. Besides monitoring existing pests and searching for new virulences in nature, some researchers, by careful study of both the crop and its pest, have predicted new virulences. In order to screen for this new predicted virulence, researchers have bred the pest with this virulence and used it to screen their materials. This approach has been used by the successful Hessian fly resistance cooperative USDA/Purdue University program. Unfortunately, these monitoring programs are more the exception than the rule. Only in the major crops with their large and highly interactive user community are these programs generally found. Even in these crops, not all aspects that may make a crop vulnerable are monitored. Where the monitoring efforts are lacking, many efforts of the plant breeder are reacting to crisis conditions. As it often takes years to release a cultivar, reacting to crisis conditions is clearly less desirable than predicting changing conditions and acting upon those conditions before a crisis has occurred.

Another example of a conscious attempt to avoid crop vulnerability is the research specifically designed to introgress unadapted materials into the adapted types. More and more, these programs are being recognized as an important part of crop improvement. Similarly, breeders are recognizing and devoting part of their efforts to "parent building" which again often utilizes unadapted germplasm. It is in these programs that many of the 304,863 samples sent in 1979 by the NPGS to the user community are used.

That 304,863 samples were available and could be sent out may be the greatest single strength of the NPGS in the eyes of the user community. The NPGS is widely used. This ready availability, coupled with the free distribution of samples, are incentives for the users to continue to access the resources of the NPGS.

The use of the NPGS depends upon the size of a user community, the structure of the collections (do they include those agronomically superior lines that most breeders use in their programs, for example), the historic use, the information available, and the ease of access. The users often maintain large collections of useful germplasm themselves. The collections contain proprietary materials, segregating materials, unshared elite lines, and occasionally released cultivars. While some of this germplasm would be a useful addition to the NPGS, many of these materials do not belong in the NPGS because they are too similar or inferior to the materials that should be or already are in the NPGS. Some breeders feel more comfortable with a one-to-one exchange where they can stipulate the use of their material, rather than giving their material to the NPGS where it would be open stock. Because these users are not officially part of the core NPGS, their policies on exchange and contributions of germplasm to the NPGS are diverse and can be as different as the individuals themselves. Similarly,

the information that this user group obtains on the various materials they receive from the NPGS is often not returned to the NPGS. At present, returning information ("feedback") is often not considered important. The individual has the information desired, and take additional time and resources would be required to return the data.

5. Information Management

Defining the present status of information management capabilities in the NPGS for the purposes of planning is a difficult task. This difficulty arises primarily from the rapid changes in information management that have taken place in the NPGS over the past 4 years, and the recent completion of a recommended design for an information-management system that would service the entire system. Much of the impetus for this rapid change in information management came from GRIP, a cooperative team of personnel from USDA-SEA and the Laboratory for Information Science in Agriculture, Colorado State University. The GRIP Team produced the design recommendations mentioned above.

Because the recommended information system design has yet to complete its review process within USDA, it is premature to accept this as the current direction of information management for germplasm. One way to present the status, then, is to describe the system as it existed 4 years ago, along with the recommended design for the future. It is important to note, however, that much of the system in operation in 1980 functions with the aid of information-management systems developed independently of GRIP.

In the GRIP Feasibility Study (June 1977), the following conclusions were reached about the existing information-management system for germplasm. "An information system exists within the plant genetic resources community of the

United States, but this system lacks the organization, communication techniques, trained personnel, and funding to satisfy the requirement of the NPGS community."

At that time, the various components of the NPGS had few common trends in their information-management techniques. The PI numbering system provided a good basis for monitoring germplasm as it entered the plant introduction system, but further control over subsequent evaluation and maintenance of the germplasm was not maintained. Each segment of the NPGS maintained its own data for its accessions--leading to redundancy in the data management and inconsistencies among data that were supposed to be identical.

The tools used to manage the data varied among the sites and ranged from manual files of index cards to computerized information retrieval systems. However, even where computers were used, the computer systems and programs were not compatible among sites (and, in at least one case, not compatible across crops at a single site) leading to an inability to easily share data within the NPGS.

The data also presented barriers to effective use within the NPGS. There was an absence of mutually agreed upon descriptors between curators and users, many accessions were (and still are) inadequately described, and many data were incorrect (with no systematic process to identify and correct them).

At the present time, most sites in the NPGS use computers for at least some aspects of their information management. Also, 10 CAC's have been formed to help the curators and users for each crop reach concurrence on which descriptors are of highest priority, how they should be measured, and what strategies should be followed for generating needed data. However, the sophistication of approach and quality control of the data still varies greatly among the sites. The GRIP design recommendations propose a centralized Data base

Management System (DBMS) for the NPGS. This technology has been adopted by many large corporations as a tool to help them manage their data as a corporate resource. If implemented, this system would manage the data as a systemwide resource.

At the core of the system would be a single data base from which everyone in the system could access the data they are authorized to use. Likewise, all changes to the data would be made to this single copy, so that discrepant "duplicate" versions of the same datum would not exist in any official file. It should be noted that backup procedures will be used so destruction of the "single" official copy will not mean loss of the data.

A Data Base Administrator (DBA) is proposed to oversee the entire system. That person (and staff) would be responsible for maintaining the integrity of the data and the system.

The users will interface with the data base through programs and packages provided to them. These interface tools have been identified for a number of functional operations that currently occur in the system. The system, as proposed, has been designed around functional patterns, but it will place some restrictions on current users. Final acceptance of the system, however, will be dependent upon a careful assessment of the ability of the system to satisfy "within-crop" needs as well as "across-NPGS" needs.

It is anticipated that this system will ultimately allow the administrators and users of the system to see the status of what they know, and don't know, about the germplasm. It will allow the germplasm to be maintained, ordered, and sent more efficiently and effectively. And it will aid in better decisionmaking by providing better and more consistent data about the status of the entire system.

B. PRINCIPAL STATIONS AND LABORATORIES

Table 4 summarizes the FY 1980 budget and SY information of the major units in the present organization. Other units, such as the germplasm maintenance and evaluation activities in Miami and Mayaguez, are included in the present organization and program, but are not elaborated.

PGGI, BARC, Beltsville, MD

This Institute is comprised of six laboratories: Germplasm Resources, Plant Taxonomy, Economic Botany, Seed Quality, Field Crops, and Tobacco. The first three of these are all involved with programs in germplasm and new crops. In addition, the EBL is involved in the narcotics program. These three program areas constitute a national program under NRP 20160. This represents an historical grouping going back to pre-1972 and the New Crops Research Branch which had responsibility for all three programs.

The other three laboratories pursue research objectives that characterize programs on most established crops and are users (and, in some cases, developers) of germplasm.

GRL - This Laboratory, including the SEA Plant Introduction Station at Glenn Dale, has 8.0 SY's and an FY 1980 operating budget of $910,100. One SY and $63,500 is on new crops, the remaining SY's and funds are on the acquisition, documentation, evaluation, and maintenance of germplasm. The PIO and the Small Grain and Rice Collections are in this Laboratory.

EBL - The mission of this Laboratory is to survey the world's plant resources in terms of their ecological and economic importance. Currently, the major program activity of the Laboratory is that of collecting, identifying, and documenting plants that may contain anticancer agents. This program is

funded by the National Cancer Institute (NCI). The other program activities concern the evaluation of economic plants as new or replacement crops based on their ecological requirements and their potential economic value. Total SY's, 2.0; funds, $621,700, of which $450,000 is reimbursable from NCI; $69,000 is reimbursable from AID for crop ecological/adapatability assessments, and $102,700 is narcotics program funds to provide backup to crop-substitution programs in Thailand and Pakistan.

Plant Taxonomy Laboratory - There are 3.0 SY's of effort and $231,700 in this Laboratory to support research on the taxonomy of cultivated plants and seed identification.

NSSL, Fort Collins, Colorado - This is the Nation's only long-term seed storage facility. In the terminology used internationally by germplasm resources specialists, the NSSL is a "base" collection as distinguished from an "active" or "working" collection. The Laboratory's mission is to maintain germplasm as near as possible to its original genetic composition for centuries to come. To carry out this mission, the Laboratory must provide the physical environment and procedural protocols which will minimize the need to regrow its stocks of seed, whether for restoration of viability or to replenish quantitatively depleted samples. These requirements translate into low and constant temperature and humidity levels and sharing its stocks only when they are not available elsewhere. It is not intended that base collections be drawn upon to meet user's needs. The Laboratory's research is concentrated on determining optimum storage conditions for each group of species with similar storage requirements. Seed viability is monitored on a regular schedule.

The Laboratory has a current inventory of approximately 117,000 accessions with about that many more on hand to be processed for eventual incorporation into the collection.

The FY 1980 budget for the Laboratory is $606,867 and it is staffed with 4.0 SY's.

RPIS

The four RPIS's are examples of effective State/Federal cooperation and integration of funds and staff to accomplish jointly-established goals. The work of each regional station is guided by a regional technical committee that has one member from each State in the region plus members from participating Federal agencies. Each regional technical committee works under a regional project (W-6, NC-7, NE-9, S-9) and has assistance of an administrative advisor (an SAES director or associate director) on policy and procedural matters as well as on funding and staffing needs that may come through the regional associations of SAES directors.

The regional coordinator at each RPIS is a SEA-AR scientist (the coordinator at Ames is on a 60/40 Federal/State appointment) and most of the other SY's are Federal. The technician, clerical, and laborer personnel are almost entirely State employees, paid either from regional funds, local SAES funds, or by SEA-AR funds through cooperative agreement.

Each RPIS has priority responsibility for a list of crops established by mutual agreement. Two or more RPIS's may maintain and distribute seed of major crops grown in their region but national priority responsibility is fixed with only one of them. These crop priority lists may include crops not maintained at the RPIS but under other curators at outlying locations in the region. Should

these outlying collections come under any jeopardy, it is the responsibility of the regional coordinator to take steps that will assure their continued safe maintenance. All regional coordinators report directly to their area director on the Federal side and may report directly to the local SAES director or through a department chairman. The coordinators have a national responsibility, however, for each of the species (sometimes numbering more than 1,000) assigned to them.

The RPIS primarily maintain "wild type" and introduced germplasm. Primary collections of some of the "major crops"; e.g., soybeans, small grains, cotton, rice, sugar beets, sugarcane, and tobacco; are maintained elsewhere in the NPGS.

The RPIS, Pullman, Washington (W-6)

This RPIS had a budget for FY 1980 of $329,164, SEA-AR, and $141,688, CR, and a staff of 4.0 SY's (3.0 Federal, 1.0 State). Alaska and Hawaii participate as members of Regional Project W-6.

The RPIS, Experiment, Georgia (S-9)

This RPIS had a budget for FY 1980 of $400,765, AR, of which $50,000 were energy funds for alcohol/biomass; and $97,418, CR. It has a staff of 4.0 SY's, all of whom are Federal employees. Puerto Rico and Hawaii (and theoretically the Trust Territory of the Pacific Islands) participate as members of Regional Project S-9.

The RPIS, Ames, Iowa (NC-7)

The budget for this station for FY 1980 was $242,508, AR; $136,850, CR; and $22,980, Iowa SAES. The station staff has 4.0 SY's, 3.6 of which are Federal and 0.4 State.

The RPIS, Geneva, New York (NE-9)

This station had a budget of $219,514, SEA-AR, and $61,500, CR. The staff includes 3.0 SY's, all Federal employees.

Interregional Potato Project (IR-1)

This interregional project focuses on potato cultivar development with strong emphasis on germplasm accessibility and upgrading to meet breeders needs. It also supports research on methods for effective maintenance of potato germplasm in the form of clonal material, either through tuber regeneration or meristem preservation in liquid nitrogen.

All four regions participate and the project members have participated actively in planning explorations for new germplasm, in developing a minimum list of descriptors for data collection as material is increased or grown for evaluation, and in planning the maintenance and distribution activities centered at the Potato Introduction Station, Sturgeon Bay, Wisconsin. IR-1 has 2 SY's and a budget for FY 1980 of $16,000 SEA-AR, $100,000 SEA-CR, and $66,800 Wisconsin SAES.

National Fruit and Nut Germplasm Repositories (Clonal Repositories)

NPGC has developed a plan for constructing, staffing, and operating 13 national fruit and nut germplasm repositories at 12 locations. These were to be jointly funded and operated by SEA-AR and the SAES involved with the latter's share of funding to come through SEA-CR.

Limited SEA-AR and CR funding has materialized to date ($1.5 million per annum) so the implementation plan is considerably behind schedule and will have to be revised. The Corvallis Repository for pears, filberts, small fruits,

hops, and mints is essentially completed and is in operation. The Grapes, Stonefruits, and Nuts Repository at Davis, California, is being implemented.

The Date Palm Repository at Indio, California, and the Tropical and Subtropical Fruits Repository at Miami, Florida, are receiving operational support from repository funds.

Other curators

In addition to the selected locations already discussed, a number of important collections are maintained by curators with less formal ties to the NPGS. Some of these curators receive limited support from SEA-AR, through cooperative agreements, but many have only an informal relationship with the NPGS. A number of important crop species; e.g., soybeans, cotton, sugar crops, sweet potatoes, flax, tobacco, and a major part of the peanut collection; are peripheral to the formal system, but integral to the total system. Even the Small Grain Collection (the largest single component of the system) is independent of the RPIS and the regional technical committees.

Another important portion of the NPGS, which falls in this category, pertains to the genetic and mutant stock collections. These are working collections of individual accessions genetically defined by a specific genetic or chromosomal trait controlled by a gene at an allele, locus, chromosome, translocation, inversion, and so on. The genetic stock centers are an essential underpinning of the research effort, both basic and applied, on plants in the United States and throughout the world. These stocks have been utilized for research and education in plant breeding, genetics, physiology, biochemistry, and molecular genetics. More specifically, advances in knowledge made possible, or at least facilitated by the existence of these stock centers have been in the areas of

gene function and processes of mutation, fine structure of genetic material, behavior and mechanisms of chromosomes, processes of starch biosynthesis, biosynthesis of storage proteins and carotenoids, existence and properties of migrating genetic materials and mutable loci, to name several prominent ones. These stocks often require specialized maintenance procedures. Examples of notable genetic stock collections are:

Barley: Over 3,000 genetic stocks, maintained by and distributed from the Department of Agronomy, Colorado State University, Fort Collins, with financial support ($20,000 per annum) from SEA-AR.

Cotton: About 300 genetic stocks, maintained by and distributed from the Agronomy Field Laboratory, Texas A&M, College Station, with financial support (terminated May 31, 1980) by the National Science Foundation (NSF). SEA-AR is taking steps to provide continued support for this collection.

Oats: Over 200 genetic stocks, maintained by and distributed from the Small Grains Collection, USDA-SEA-AR, Beltsville, with total support from SEA-AR.

Peas: 5,000 single mutants, genetic stocks, multimarker lines, linked genes, maintained by and distributed from the Department of Seed and Vegetable Sciences, New York SAES, Geneva, presently supported by the New York SAES; however, SEA-AR has been asked to assume these costs.

Tomatoes: 1,700 genetic and chromosomal stocks of *Lycopersicon esculentum* and related species, maintained by and distributed from the Department of Vegetable Crops, University of California, presently supported by the NSF.

Wheat: 600 genetic stocks, maintained by and distributed from SEA-AR scientists at the University of Missouri, Columbia, and totally supported by SEA-AR.

Corn: About 51,000 different genotypes, in addition to translocations, and other chromosome or cytological stocks, are maintained and distributed from the Maize Genetics Cooperation Stock Center, Department of Agronomy, University of Illinois, Urbana, with financial support (about $60,000--cooperative agreement) from SEA-AR.

Table 4. Funding of Selected Major Units Within the NPGS (1980)

Unit	AR	CR	Other*	FY 80 SY's
Plant Genetics Germplasm Institute				
Germplasm Resources Laboratory	$ 910,100			8.0
Economic Botany Laboratory	102,700		$450,000 NCI 69,000 AID	2.0
Plant Taxonomy Laboratory	231,700			3.0
National Seed Storage Laboratory	606,867			4.0
Regional Plant Introduction Stations				
W-6, Pullman, Washington	329,164	$141,688		4.0
S-9, Experiment, Georgia	400,764	97,418	16,500 GA SAES	4.0
NC-7, Ames, Iowa	242,508	136,850	22,980 Iowa SAES	4.0
NE-9, Geneva, New York	219,514	61,500		3.0
Interregional Potato Introduction Station (IR-1)	16,000	100,000	66,800 Wisconsin SAES	2.0
National Fruit and Nut Germplasm Repositories	1,000,000	500,000		
Germplasm Resources Information Project (GRIP)	500,000		120,000 USDA-CDSD	

*Does not include contributions to Regional Plant Introduction Stations that include space, utilities, and equipment.

Section IV.

MANAGEMENT COMPONENTS

While the management components of the NPGS are presented with relative simplicity in Section III, it is important to recognize some of the interrelating administrative elements which impact upon the NPGS.

While the lead role in coordinating the NPGS is handled by AR, much of the user community, and some curators, are in the State and private sectors. Those workers at the State agricultural experiment stations may be funded by formula Federal funds (primarily Hatch) distributed by CR, by State appropriations, by CR-administered special grants, or by other trust or gift funding sources. The NPGS also interacts (through germplasm requests and exchanges) with foreign workers and university scientists who are not affiliated with the State agricultural experiment stations. This latter group would generally be considered to be served by, but not part of, the NPGS.

Another factor is APHIS, which conducts a quarantine program which has an impact upon all plant introductions entering the NPGS. This Agency is responsible for certification of phytosanitation for germplasm leaving the United States. A close working relationship between APHIS and the PIO (and individual curators, particularly of the working collections) is essential. The basic charges to APHIS (to destroy dangerous material) and to the NPGS (to preserve germplasm) often present somewhat difficult situations requiring cooperation between workers in different administrative lines.

Section V.

ADVISORY COMPONENTS

NPGRB

The NPGRB serves a vital role in the NPGS by offering policy advice directly to the Secretary of Agriculture. The NPGRB also serves as a visible exponent of the need for a unified national system to preserve and manage so precious a resource as plant germplasm. The Secretary's Memorandum which reestablishes the NPGRB and describes its responsibilities is included in appendix G, along with a listing of the current membership.

NPGC

This Committee was established on May 20, 1974, when the Agricultural Research Service (ARS) agreed to a restructuring of the National Coordinating Committee for New Crops, which had been created in 1949 by SAES directors. The membership of the NPGC is provided in figure 3. The purposes of the NPGC are:

- Provide coordination for the research and service efforts of Federal, State, and industry units engaged in the introduction, preservation, evaluation, and distribution of plant germplasm, through representation of the views of all units by members of the Committee.
- Develop policies for the conduct of the national plant germplasm program and for its relationships to international plant germplasm programs.
- Develop research and service proposals and justification for adequate funding of regional and national plant germplasm activities.
- Actively advocate mutually agreed upon proposals with SAES associations and USDA agencies.

Figure 3. National Plant Germplasm Committee--Present Membership

State

Regional Administrator, W-6

Regional Administrator, S-9

Regional Administrator, NC-7

Regional Administrator, NE-9

Federal

National Research Program Leader, Germplasm

National Research Program Leader, Genetics

Regional Coordinator, W-6

Regional Coordinator, S-9

Regional Coordinator, NC-7

Regional Coordinator, NE-9

Plant Introduction Officer

Assistant Administrator, CR

Private

National Council of Commercial Plant Breeders

- The Committee forum will also be the principal way in which SAES interests can be presented and harmonized with Federal interests at a technically informed level.

The NPGC was chartered to meet at least once each year.

Regional technical committees

Each of the four regions has a regional technical committee (NE-9, NC-7, S-9, W-6) composed of a representative from each State agricultural experiment station in the region and from SEA and SCS and, in some cases, FS and BLM. Each of these committees has an administrative advisor who is an SAES director. The regional technical committees provide technical advice to the RPIS and make policy recommendations to the NPGC. Each committee is represented on the NPGC by its respective administrative advisor (and coordinator).

Crop advisory committees

Crop advisory committees are part of a concept initiated through GRIP to represent the germplasm user community and provide guidance and coordination to the NPGS. There are currently 10 committees--one each for wheat, oats, sorghum, potatoes, tomatoes, alfalfa, beans, peas, soybeans, and corn. The committees are composed of plant scientists drawn from the public sector, both the Federal and State, as well as from the private sector. The curator of the crop is a member of each committee. The committee provides both general and specific guidelines, policy and work programs for various phases of work, and activities in the germplasm management of a specific crop. The GRIP team has served as facilitators for the committees.

The committees have worked on problems of exchanging information and have developed minimum lists of descriptors to characterize each crop. They have

also developed germplasm evaluation plans. Other pertinent issues addressed by the committees are:

- Germplasm acquisition strategies
- Working collection storage conditions
- Long-term storage conditions
- Regeneration
- Seed distribution guidelines
- Standards for germplasm evaluation
- Plant exploration guidelines

APPENDICES

Appendix A

NATIONAL FRUIT AND NUT GERMPLASM REPOSITORIES
Conceived and Planned by
THE NATIONAL PLANT GERMPLASM COMMITTEE
In Conjunction With
State Agricultural Experiment Stations,
Science and Education Administration,
Cooperative Research and
Agricultural Research

Revised May 1, 1980

A. THE CONCEPT of national fruit and nut germplasm repositories.

1. National fruit and nut repositories will be located at various locations where research facilities of State agricultural experiment stations or Science and Education Administration (SEA)-Agricultural Research (AR) already exist.

2. These repositories will be located in areas of the country where the germplasm is most likely to survive environmental conditions and natural pests.

3. These repositories will contain a wide array of primitive and advanced germplasm collected from within the United States and from around the world.

4. The germplasm of these repositories will be collected, evaluated, maintained, and preserved so as to benefit the continued improvement of horticultural characteristics of economic crops.

5. These repositories will serve public, industry, and private plant breeders and plantsmen in the United States and, to the extent possible, will also serve plant breeders and plantsmen around the world.

6. Germplasm of these repositories will be maintained free of viruses, diseases, and other pests to the extent that it is practical and economical to do so.

7. These repositories will be separate and distinct from any plant breeder's working collection at the same location.

8. Plant breeders and plantsmen from the State agricultural experiment stations, SEA-AR, industry, and the private sector will serve as advisors for each repository.

9. These repositories will be jointly funded by the State agricultural experiment stations and the SEA-AR.

10. These repositories will be jointly managed by the State agricultural experiment stations, the SEA-AR, and the National Plant Germplasm Committee.

11. The system of joint management of these repositories will be similar to that now used for the regional plant introduction stations and regional plant introduction coordinators will play a key role in providing technical supervision.

12. The repositories will be closely associated with the regional plant introduction stations and will support regulations of the Animal and Plant Health Inspection Service (APHIS), U.S. Department of Agriculture (USDA), and other regulatory agencies controlling introduction and shipment of plant material.

13. These repositories will be established and staffed as funds are available and will be continuously supported thereafter.

B. THE OBJECTIVES of the national fruit and nut germplasm repositories.

1. The primary objectives of national fruit and nut germplasm repositories are to maintain and preserve valuable fruit and nut germplasm and to make such germplasm readily available to plant breeders and plantsmen.

2. The secondary objectives of the national fruit and nut germplasm repositories are to collect worldwide accessions of valuable fruit and nut germplasm, to evaluate such accessions, and to conduct and encourage appropriate research relating to improved methods of evaluation, propagation, preservation, storage, and distribution of clonal material.

C. THE LOCATIONS AND COMMODITIES of the national fruit and nut germplasm repositories.

1. State agricultural experiment station locations:

   a. Davis, California -- stone fruits, grapes, walnuts, almonds, pistachio nuts.

   b. Geneva, New York -- apples and grapes.

   c. Riverside, California -- citrus, figs, and certain other subtropical fruits.

   d. Poamoho and Kona, Hawaii -- macadamia nuts and subtropical fruits.

   e. Carbondale, Illinois -- black walnuts, chestnuts, and hickories.

2. Science and Education Administration-Agricultural Research locations:

   a. Corvallis, Oregon -- strawberries, caneberries, blueberries, pears, filberts, hops, and mint.

   b. Byron, Georgia -- stone fruits and apples.

   c. Orlando, Florida -- citrus.

   d. Miami, Florida -- avocados, mangos, and other subtropical fruits.

   e. Mayaguez, Puerto Rico -- coffee, cocoa, bananas, pineapples, and mangos.

   f. Indio, California -- dates.

   g. Brownwood, Texas -- pecans.

D. THE CONSTRUCTION AND STAFFING SEQUENCE of the national fruit and nut germplasm repositories. (To be determined.)

E. THE ALLOCATION OF FUNDS for the national fruit and nut germplasm repositories. (To be determined.)

F. THE MANAGEMENT SYSTEM for the national fruit and nut germplasm repositories.

1. Curators

   a. Number. There will be a Curator for each repository.

   b. Appointment. The curator, with the concurrence of the NPGC, will be appointed by the director of the respective State agricultural experiment station or by the area director of the respective SEA-AR locations.

   c. Responsibilities. The curator will be responsible for:

      1. Establishment, maintenance, and preservation of germplasm of the repository.
      2. Evaluation of germplasm maintained in the repository.
      3. Ascertainment of trueness to name of germplasm maintained in the repository.
      4. Maintenance of current inventory and development of an information system for the germplasm maintained in the repository.
      5. Preparation and distribution of appropriate publications describing the germplasm maintained in the repository.
      6. Support of existing Federal and State regulations on the introduction and shipment of plant material to and within the United States.

7. Elimination of viruses, diseases, and other pests from the repository to the extent that it is practical and economical to do so.

8. Distribution of germplasm from the repository and documentation of such distribution.

9. Initiation and encouragement of appropriate research relating to the evaluation, propagation, preservation, storage, and distribution of germplasm from the repository.

10. Publicity on the functions and services of the repository and promotion of its use.

11. Preparation of an annual budget required for the maintenance of the repository and its service functions.

12. Supervision of clerical and support staff and daily operations of the repository so as to make maximum use of allocated funds.

13. Accountability for public funds and property.

14. Responsible to make local arrangements for the meetings of the technical advisory committee.

d. Supervision. The curator at a State location will receive administrative and technical supervision from the regional coordinator of his region. The curator at a Federal location will receive administrative supervision from the local research leader or area director and technical supervision from the regional coordinator of his region. The curator will also receive advice from the technical advisory committee.

2. Technical Advisory Committees

a. Number. There will be a technical advisory committee appointed for each of the 12 planned repositories. Each of the committees will

be appointed as soon as possible after authorization for construction is received. The planned repositories are as follows:

Corvallis, Oregon	Byron, Georgia
Davis, California	Orlando, Florida
Geneva, New York	Miami, Florida
Riverside, California	Mayaguez, Puerto Rico
Poamoho and Kona, Hawaii	Indio, California
Carbondale, Illinois	Brownwood, Texas

b. Membership.

1. There will be a member and an alternate appointed to each repository committee to represent each of the major commodities or group of crops to be maintained at each repository.

2. The regional coordinator will be a permanent member and be responsible for the organization and operation of each technical advisory committee in their respective regions.

c. Appointment of committee members.

1. Appointments to the technical advisory committees will be made by the Chairman of the National Plant Germplasm Committee.

2. Nomination of members to serve on the technical advisory committees will be sought from the national germplasm repository groups or from SEA-AR and from the SAES involved in the repository.

3. Members will be appointed on the basis of interest in plant germplasm and willingness to serve. Membership will include representatives from State agricultural experiment stations,

Federal research, and private industry. Considerations will be given to provide national representation on each technical advisory committee.

d. Committee Chairman. Members of each technical advisory committee will annually elect a committee chairman who will conduct the activities of the committee.

e. Responsibilities. The technical advisory committee will have the following responsibilities:

1. Establish procedure for committee activities including length of service for each member and procedures for nominating replacements to the Committee.

2. Review and develop plans, procedures, and operations for the germplasm repository and recommend to the National Plant Germplasm Committee policy and procedures for the operation of the repository.

3. Recommend what germplasm will be maintained, added, or discarded from individual national germplasm repositories.

4. Recommend priorities relating to research planned or needed at each repository.

5. Assist the curators in the publicity on the functions and services of the repository and in the promotion of repository use.

f. Meetings. There will be at least one meeting annually of each technical advisory committee, subject to call of the Chairman.

g. Travel expenses. Expenses for official travel to technical advisory committee meetings may be paid from funds appropriated

for establishing and maintaining national fruit and nut germplasm repositories but all such payments must be made or arranged by the Committee member's own institution or organization.

Appendix B

The Soil Conservation Service Cooperative Plant Materials Program

Vegetation is a significant component of more than two-thirds of the conservation practices farmers, ranchers, and others find essential to the solution of their erosion and land use problems. These problems require a wide variety of plant materials, some of which have a limited but vital application.

To help meet the many needs for improved plant materials, the Soil Conservation Service (SCS) operates, funds, or provides technical assistance to plant materials centers. These centers are strategically located throughout the United States so that the results of their plant testing and development work help meet the need for adapted plants in reducing erosion and sedimentation in most areas of the country.

These centers assemble, comparatively test, select, and provide for the commercial increase of plants needed for reducing erosion and sedimentation where suitable plants are not presently available. They also develop techniques for the successful use of selected plants with special emphasis given to finding plants and techniques for use on eroding soils and sites where it is difficult to establish vegetation. The work of these centers is coordinated with but does not duplicate the work of research agencies. Rather, this comparative plant materials work fills a need of an action-oriented agency and serves as a bridge between soil conservation plant materials problems and research agencies.

Eighteen plant materials centers are operated by the SCS and two by cooperating agencies. They are:

Operated by Soil Conservation Service:

Tucson, Arizona	East Lansing, Michigan

Lockeford, California

Brooksville, Florida

Americus, Georgia

Molokai, Hawaii

Aberdeen, Idaho

Manhattan, Kansas

Quicksand, Kentucky

Beltsville, Maryland

Coffeeville, Mississippi

Elsberry, Missouri

Bridger, Montana

Cape May Courthouse, New Jersey

Big Flats, New York

Corvallis, Oregon

Knox City, Texas

Pullman, Washington

Operated by cooperating agencies but funded by the Soil Conservation Service 1/:

Los Lunas, New Mexico (New Mexico State University)

Bismarck, North Dakota (North Dakota Association of Soil Conservation Districts)

Other:

In addition to the 20 centers listed above, the State of Alaska operates a plant materials center at Palmer; and the White River and Douglas Creek Soil Conservation Districts have established an environmental plant center at Meeker, Colorado 2/. The SCS provides technical assistance to these centers through cooperative agreements.

Comparative Plant Testing

Approximately 16,000 domestic and foreign plant collections are being comparatively evaluated at any one time at plant materials centers and at off-center sites in

---

1/ SCS has professional people at these locations providing assistance to the non-Federal cooperators.

2/ SCS has assigned one PFT.

the States served by a particular center. These collections are evaluated for a number of conservation needs such as:

1. Converting land not suited for intensive crop production to permanent cover;
2. Pasture and rangeland plant species that extend the livestock grazing season, give better soil protection, and produce superior slopes, recreation sites, and urban and industrial development areas;
3. Improving water quality through the stabilization of critical, high-yielding sediment sources such as surface mined lands, highway slopes, recreation sites, and urban and industrial development areas;
4. Control of critically eroding areas such as coastal sand dunes;
5. Protection of coastal, river, streambank, pond, and lake waterlines from erosion by wave action;
6. Improvement of windbreaks and shelterbelts for the reduction of airborne sediment, control of snow drifting, and the prevention of crop damage resulting from wind erosion;
7. Improved wildlife food and cover species and special plants for esthetic and recreational purposes;
8. Stabilization of land disposal areas;
9. Fire-retarding plant cover to replace brush or mountain foot slopes to reduce the possibility of fires that threaten life and property or result in serious sediment sources; and
10. Multiple-use plants which also provide environmental protection and enhancement.

Plants or techniques showing potential for helping to solve a conservation problem are comparatively evaluated under actual use conditions on properties of cooperators.

Cooperation

Most of the plant materials work is carried out in cooperation with other Federal agencies and State experiment station, State highway agencies, and State departments of natural resources, conservation, or wildlife. SCS also works closely with commercial businesses and seed and nursery associations to encourage production of improved plants and to promote their use in conservation programs.

Benefits

The SCS plant materials centers have released over 200 different varieties of conservation plants for commercial production and use in conservation programs. Over the years, some of those varieties have been replaced with superior plants. Currently, there are about 150 SCS-released varieties in commercial production and use in conservation programs. Thirty-two improved varieties of conservation plants were cooperatively released to commercial growers in 1978 and 1979.

In the earlier years of this program, selected plants needed for use in conservation programs were sometimes simply made available to commercial seed growers and nurserymen. Today selected plants are released in cooperation with State agricultural experiment stations and frequently with other Federal and State agencies.

Commercial Production

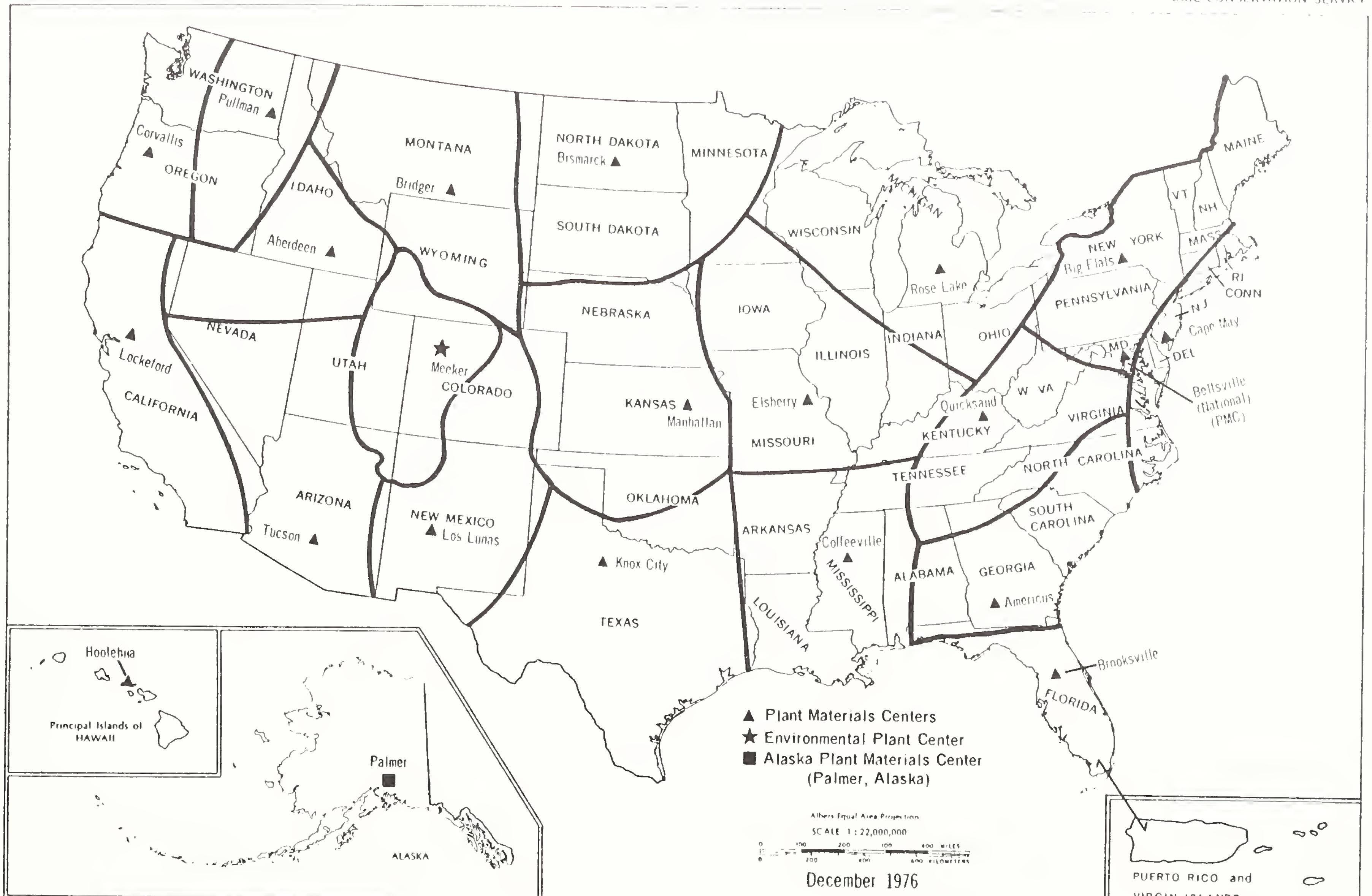
The estimated commercial production of the 150 SCS-released varieties in 1978 was approximately 7,000,000 pounds of seed, 7,000,000 woody plants, and millions of clones and sprigs of vegetatively produced plant materials, such as 'Cape' American beachgrass. This production had a retail value in excess of $27,000,000. More significantly, this production was the equivalent of the amount of seed

and plants required to provide conservation treatment to approximately 1.5 million acres of land. The appropriations for operating these plant materials centers was $2,693,000 in each FY 1979 and 80.

U. S. DEPARTMENT OF AGRICULTURE

Location and Service Areas of Plant Materials Centers

SOIL CONSERVATION SERVICE



USDA SCS HYATTSVILLE MD 1977

Appendix C

NATIONAL SEED STORAGE LABORATORY

POLICY STATEMENT

General

1. The Laboratory is a Federal facility and all seed accepted for long-term storage becomes the property of the U.S. Government and remains so until released by the Laboratory.
2. Only seeds are accepted for storage in accordance with the following policy guidelines.
3. The principal mission of the Laboratory is long-term preservation of valuable plant germplasm as viable seed. The Laboratory conducts research in support of its principal mission. Long-range studies focus on biochemical-physiological and genetic changes in seed during storage and effects of seed moisture content, storage environment, and storage containers on seed longevity. Laboratory procedures for accurate monitoring of seed viability during storage are established on a crop-by-crop basis.
4. The Laboratory issues periodic inventories of the stocks held in long-term storage to inform research workers of materials available.
5. All foreign proposals for storage will be reviewed for approval by the AR Plant Germplasm Coordinating Committee. In making its decisions, the Committee will be guided by recommendations of appropriate crop advisory committees. Acceptance for storage may require an exchange of letters between AR and the requesting agency or institution. Collections accepted for long-term storage (i.e., base collections) will be accessioned and incorporated as an integral part of the Laboratory and hence the U.S.

National Germplasm System. Collections for temporary or emergency storage may be accepted but under terms specified in the exchange of letters between AR and the requestor.

Accessioning

6. In keeping with policy here set forth, the Laboratory Director accepts valuable seed stocks from U.S. Federal and State institutions, commercial seed interests, private individuals and, as specified in item 5 above, from foreign institutions. Information as to source of individual accessions is essential. Genetic composition and complexity of improved stocks should be documented as thoroughly as possible.
7. Only clean seed of reasonably high germination is acceptable for storage. Seed of low viability will be held on a tentative basis until the donor is able to provide replacement seed of acceptable viability.
8. After seed is accepted officially, the Laboratory, unless exempted by specific agreement, is responsible for future increases necessitated by viability decline or stock depletion.
9. The Laboratory assumes no responsibility for replenishment when stocks received are subminimal in quantity or viability. However, for obsolete varieties or rescued collections not meeting the preceding acceptable standards, the Director of the Laboratory in consultation with appropriate crop specialists may make arrangements for their increase.
10. The acceptance of seed of commercial varieties by the Laboratory shall not be considered in any way Federal endorsement as to the value of the variety.

Distributing

11. Any bona fide research worker of the United States, its territories and possessions may receive, without charge, seed from the collections stored at the Laboratory, but may be requested to return a portion of the increased seed for any item which requires immediate increase. Foreign research workers also may receive seed under the same conditions, provided the U.S. Government and that of the country concerned will permit reciprocal exchange of plant germplasm. No seed will be distributed if it is commercially available or can be located in working stocks of cooperating agencies. The Principal Plant Introduction Officer will provide alternate sources of supply.
12. The Laboratory is not responsible for errors which may occur in original documentation including the cultivar name supplied by the donor.

Appendix D

BUDGET HISTORY FOR THE NATIONAL SEED STORAGE LABORATORY

Year	Sci. Effort	Sci. Support	Support Services	Equipment	Extramural	TOTAL
1971a/	$ 74,600		159,900			$ 94,000
1972a/	66,331		22,872	8,028		97,231
1973a/	71,643		16,000			87,643
1974	24,600	49,300	7,200	1,300		82,400
1975	26,000	54,600	24,900	1,300		106,800
1976b/	73,200	101,700	52,700	15,000		242,600
1977	78,100	148,300	159,900	10,000	16,500	412,800
1978	106,300	143,200	147,400	12,300	16,500	425,700
1979	111,100	161,300	133,700	2,000	16,500	424,600
1980	130,100	187,600	102,600	8,500	16,500	445,300
1981	136,400	192,400	83,000	19,000	16,500	447,300

a/ Scientific effort and support effort combined.

1976 b/

Base	63,500	94,600	99,000	15,000		272,100
Increase (1/4)	9,700	7,100	42,700	0		59,500
Subtotal	73,200	101,700	141,700	15,000		331,600
Decrease			- 89,000			89,000
Total	73,200	101,700	52,700	15,000		242,600

Appendix E

NUMBER OF EMPLOYEES AT NSSL BY YEAR

Year	Scientists	Office	Technicians	Temporary	Stay-in-School	Total
1958	2	2	1			5
1959	2	3	4			9
1960	2	2	3			7
1961	2	3	4			9
1962	2	4	4			10
1963	2	3	4			9
1964	2	3	4			9
1965	2	4	4			10
1966	2	4	4			10
1967	2	3	4			9
1968	2	4	5			11
1969	2	4	3			9
1970	2	4	4			10
1971	1	2	4			7
1972	2	2	6			10
1973	3	2	4			9
1974	3	3	5	8	1	20
1975	3	2	10		3	18
1976	4	3	13		3	23
1977	4	4	9		2	19
1978	4	4	10		4	22
1979	4	6	9		3	22
1980	4	5	9		3	21
1981	4	5	8		2	19

Appendix F

Site Selection and Facility Requirements for the National Seed Storage Laboratory

Subcommittee Report
National Plant Germplasm Committee

Members present: Byrd Curtis (for Bill Brown), Chester Evans, Clarence Grogan, Bob Hougas, Norman James, Gilbert Lovell, Howard Waterworth. Consultant: Louis Bass.

The subcommittee met at Fort Collins, Colorado, on October 15-16, 1980, to consider an appropriate site and facility requirements for long-tern seed storage. The present facility would be filled to capacity now if all seed lots stored in boxes were placed in individual container storage. Additionally, there is a serious shortage of work space for receiving cataloging, and germination testing. Supplies and equipment are stored and placed in hallways. There is inadequate laboratory space for the research component that is an essential part of the activity.

After discussion, forward planning for 25-30 years was considered appropriate because of possible advances in germplasm preservation and construction technology.

Site selection: The subcommittee considered suitability of Fort Collins as a site for expansion. Although Fort Collins is about 50 miles north of an atomic power plant and about 65 miles north of a military arsenal, selection of an alternate site would not guarantee that it would be a safer location in the years ahead. Installation of atomic or military facilities is beyond the control of those interested in germplasm preservation. Prevailing winds generally would carry fallout away from Fort Collins in case of a nuclear accident or strike

involving the existing atomic and military facilities. Only background radiation levels have been recorded on the campus of Colorado State University (CSU).

Climatic conditions are favorable at Fort Collins with low humidity, low night temperatures during summer, and low day and night temperatures during winter. these factors contribute to reduced energy costs. Severe weather conditions, such as tornados, rarely occur that would threaten the long-term storage facility.

Expansion of the present Laboratory will be more efficient than construction of additional facilities even a few miles away because of time loss and transportation costs required to operate two facilities. Construction of an entirely new facility at a distant location in the United States would result in abandonment of the present Laboratory or duplication of personnel and equipment at the two locations.

The present location of the Laboratory on the Colorado State University campus provides an opportunity for cooperative research between SEA/AR and CSU scientists. It also permits visiting scientists from the United States and abroad to obtain additional training while conducting research in the National Seed Storage Laboratory (NSSL).

For the above reasons, the subcommittee recommends expansion of the present facility. To reduce energy costs and to provide additional protection from natural hazards and nuclear events, seed storage below ground is recommended.

<u>Option I</u>: Construct facility on the west side of the existing Laboratory with two floors below ground for seed storage and one floor above ground for supporting activities. Gross dimensions: 60 feet x 160 feet.

If two floors cannot be constructed below ground because of the water table or for other reasons, construct facility with one floor below ground for seed storage and one floor above ground for supporting activities. Gross dimensions: 120 feet x 160 feet.

Renovate seed storage rooms in existing Laboratory for supporting activities.

Utilize energy efficient construction technique.

NOTE: A long-term lease will be required because the property is owned by Colorado State University.

Option 2: Construct facility on the east side of the existing Laboratory. Dimensions would be limited to 41 feet x 160 feet by a sidewalk and street. The property is owned by the Federal Government, but three floors would be required to provide seed storage below ground and two floors above ground for supporting activities. This may not be possible because of water table or other reasons. Seed storage above ground is not recommended because of energy costs, natural hazards, and possible nuclear events.

Under option 2, several variations are possible depending on the number of floors that can be constructed below ground. Renovation of existing seed storage rooms for other uses may not be practical if part of the seed storage must be above ground in the proposed expansion. Some saving in energy costs would result by providing all seed storage in new energy efficient construction above ground but an estimate of savings is not available at this time.

Estimated cost:

Option 1: 28,800 sq. ft. at $100 per sq. ft. = $2,880,000 plus renovation cost (not estimated at this time).

Inflation at 15 percent per year will increase cost in 1981 to $3,312,000 and in 1982 to $3,808,800.

Option 2: 32,800 sq. ft. at $100 per sq. ft. = $3,280,000 plus cost of renovation, if practical.

NOTE: Dimensions for new construction can be adjusted to provide cost equal to option 1.

Need for policy and procedure to determine appropriate material for long-term storage: Current policy at the National Seed Storage Laboratory is to accept, for long-term storage, essentially all cultivars, inbred lines, germplasm lines, and seeds collected by expeditions. Long range, this policy will result in continued need for expansion of storage facilities. The subcommittee recommends evaluation of the current policy. Is it necessary to accept for long-range storage all seed lots submitted? Should all seed lots now in storage be retained? It is likely that crop specialists could provide the best answers to these questions.

Appendix G

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20250

March 4, 1980

SECRETARY'S MEMORANDUM NO. 1875 REVISED

National Plant Genetic Resources Board

The Secretary of Agriculture hereby renews the National Plant Genetic Resources Board. The task of the Board is to advise on the assembly, description, maintenance, and effective utilization of the living resources represented by crop cultivars, primitive and wild forms of our crops. These resources are necessary for plant scientists to have the genetic variability necessary to cope with problems of today and the future.

The Plant Genetic Resources Board objectives are to advise the Secretary of Agriculture and officers of the National Associate of State Universities and Land Grant Colleges in order to assess national needs and identify high priority programs for conserving and utilizing plant genetic resoures, including collection, maintenance and description of genetic stocks, and utilization of the stocks in plant improvement programs.

The duties of the National Plant Genetic Resources Board are (1) to inform themselves of domestic and international activities to minimize genetic vulnerability of crops; (2) to formulate recommended actions and policies on collection, maintenance and utilization of plant genetic resources; (3) to recommend actions to coordinate the plant genetic resources plans of several domestic and international organizations; (4) to recommend policies to strengthen plant quarantine and pest monitoring activities; and (5) to advise on new and innovative approaches to plant improvement.

The Board will meet at least twice each year and possibly more often. The estimated annual operating costs are $600 for support; $8,000 for assisting in the operation of the Board; $21,000 for travel expenses, including per diem or subsistence incurred by Board members and Department employees; $15,000 from sources outside the government; and 0.4 man years. This estimate includes all private and public funds to be spent by or on behalf of the Board.

Members of the Board will be appointed by the Secretary. Pursuant to the provisions of Public Law 95-113, the Board shall, to the extent practicable, have ethnic, racial, and sexual balance. Membership on the Board will be composed of individuals with diverse capabilities distinguished by their knowledge and interest in plant genetic resources management.

In the event the board tenure is over a period of years, partial rotation of membership would be practiced every two years to provide for continuity and broad representation on the Board.

The Director of Science and Education will be Chairman. The Executive Secretary will be provided by the Science and Education Administration.

The Board shall report to the Secretary of Agriculture through the Director of Science and Education. The Director will provide support for the operations of the Board.

The functions of this Board cannot be performed in less than two years, and renewal of the Board is considered in the public interest. No existing committee can perform these functions, nor can the Department take effective unilateral action in view of the diversity of interested groups, and as such will serve an essential function.

This memorandum also serves as the charter for the Board.

In accordance with regulations for Federal advisory committees, the Board shall terminate two years from the date of this memorandum. The Department of Agriculture would like to (1) ensure continuity and increased involvement of the Board in genetic resources planning and coordination activities, (2) increase the association of the activities of the Board with genetic resource programs of State and private industry research organizations, and (3) expand the scope of the Board to relate to other kinds of genetic resources of great interest to agriculture.

Secretary's Memorandum No. 1875 Revised, dated February 23, 1978, and Supplement No. 1, dated September 7, 1979, are hereby superseded.

/signed/ Bob Bergland

Secretary of Agriculture

Appendix H

NATIONAL PLANT GENETIC RESOURCES BOARD MEMBERSHIP

CHAIRMAN

Dr. A. R. Bertrand
Director, USDA-SEA
217-W Admin. Building
Washington, DC 20250
(202) 447-5923

VICE CHAIRMAN

Dr. William L. Brown
Chairman, Pioneer Hi-Bred International
1206 Mulberry Street
Des Moines, IA 50309
(515) 245-3587

EXECUTIVE SECRETARY

Dr. C. O. Grogan
Assistant Deputy Administrator
USDA-SEA-CR
6017 South Building
14th & Independence Ave., SW.
Washington, DC 20250
(202) 447-6195

MEMBERS

Dr. D. F. Beard
Vice President - Research
Water-Loomis Company
10916 Bornedale Drive
Adelphi, MD 20783
(301) 937-6449

Dr. Paul J. Fitzgerald
Regional Administrator
USDA-SEA-AR-NCR
2000 West Pioneer Parkway
Peoria, IL 61615
(309) 671-7176

Dr. W. H. Gabelman
Department of Horticulture
University of Wisconsin-Madison
Madison, WI 53706
(608) 262-1490

Dr. Charles O. Gardner
Department of Agronomy
The University of Nebraska-Lincoln
Lincoln, NE 68583
(402) 472-2811

Dr. Stanley L. Krugman
Principal Research Forest Geneticist
USDA Forest Service
P.O. Box 2417
Washington, DC 20013
(202) 235-8200

Dr. Harold D. Loden
Executive Vice President
American Seed Trade Association
1030 15th Street, NW.
Washington, DC 20005
(202) 223-4080

Dr. Don C. Peters
Professor and Head
Department of Entomology
Oklahoma State University
(405) 624-5527

Dr. Charles M. Rick
Professor and Geneticist
Department of Vegetable Crops
University of California
Davis, CA 95616
(916) 752-1737

Dr. H. F. Robinson
Chancellor
Western Carolina University
Cullowhee, NC 28723
(704) 227-7100

Dr. Hugo Graumann
1714 Edgewater Parkway
Silver Spring, MD 20903

EX-OFFICIO MEMBER

Dr. Wilson H. Foote
Associate Director, SAES
Oregon State University
Corvallis, OR 97331
(503) 754-4251

Dr. G. F. Sprague
Professor, Plant Breeding and Genetics
Department of Agronomy
University of Illinois
Urbana, IL 61801
(217) 333-4254

Appendix I

THE INTERNATIONAL BOARD OF PLANT GENETIC RESOURCES

The International Board for Plant Genetic Resources (IBPGR) is an autonomous, international, scientific organization under the aegis of the Consultative Group on International Agricultural Research (CGIAR). The IBPGR, which was established by the CGIAR in 1974, is composed of 15 members from 13 countries; its Executive Secretariat is provided by the Food and Agriculture Organization (FAO) of the United Nations, Rome.

The basic function of the IBPGR, as defined by the Consultative Group, is to promote an international network of genetic resources centers to further the collection, conservation, documentation, evaluation and use of germplasm and thereby contribute to raising the standard of living and welfare of people throughout the world. The Consultative Group mobilizes financial support from its members to meet the budgetary requirements of the Board.

The total pledged so far for 1980 is $3,025,000. The five largest donors are: USA ($750,000), Japan ($400,000), World Bank ($365,000), United Kingdom ($270,000), and West Germany ($220,000).

The Board's budget has progressed as follows (rounded to nearest $1,000):

1974 - $ 53,000	1977 - $1,258,000	1980 - $3,239,000 (approved)
1975 - $487,000	1978 - $2,008,000	1981 - $3,654,000 (projected)
1976 - $915,000	1979 - $2,738,000	

The budget level for 1980 will continue for the forseeable future except for cost-of-living increases (estimated at 10 percent) or unanticipated program expansion.

Costs of the Secretariat at headquarters in Rome are shared approximately equally between the Board and FAO.

THE NATIONAL PLANT GERMPLASM SYSTEM

II. STRENGTHS AND WEAKNESSES

CONTENTS

PREFACE

This report represents the second part of a long-range plan for the National Plant Germplasm System (NPGS). The first part is an objective statement of the current status of the NPGS. This report addresses the strengths and weaknesses of the NPGS and is intended to serve as a checklist of important points in developing the positive long-range plan, which is presented in a third report.

An assessment of strengths and weaknesses is, by its very nature, judgmental. This report, however, benefits especially from interactions with two General Accounting Office (GAO) teams, from the Germplasm Workshop (Peoria, Illinois, March 9-11, 1981), and from the inputs and review of a task force representing a broad range of expertise within the NPGS.

While the NPGS is probably the strongest link in the international network of germplasm resources, it is an imperfect system which merits attention. It is indeed true that a long-range plan must build on the strengths of the existing system, but it is even more important that the plan attempt to correct, or at least compensate for, the weaknesses of that system. This report does address the significant strengths of the NPGS, but it most critically examines the system's weaknesses. Most of the weaknesses presented are addressed in some way in the long-range plan. There are a few problem areas, however, for which no immediate solution is evident, but which are deemed important enough to merit further intensive attention.

Section I.

INTRODUCTION

It is important that the long-range plan for the National Plant Germplasm System (LRP-NPGS) be a positive, proactive document. It will only have meaning, though, if those responsible for both the administration and operation of the NPGS will accept this, and other critiques of the system, as positive attempts to identify both strengths and weaknesses upon which an optimal NPGS can be built. Germplasm resources are a vital national asset which has been too long neglected. At a time when these resources are finally receiving some much needed attention; thoughtful review, analysis, and debate is imperative. Defensiveness and lack of flexibility, though much more natural responses, can only be counterproductive.

While all of the strengths and weaknesses cited in this report are considered important, certain of them were considered by the task force to merit special attention. These are highlighted in the text with one or more asterisks (*).

Section II.

WORKING COMPONENTS

A. PLANT INTRODUCTION

Strengths

Procedure in existence: A formalized plant introduction procedure is currently in existence and a working unit, the Plant Introduction Office (PIO), is in operation. This office also has a working relationship with the Animal and Plant Health Inspection Service (APHIS).

Recognized need: Due to the lack of native crops, the development of American agriculture has been dependent upon introduced plant material. This historical dependence continues to the present with both the user community and the NPGS well aware not only of past accomplishments, but also of future needs to continuously add genetic diversity and new crops to our germplasm collections.

Strong exchange system: A good working relationship exists between the NPGS and many other countries. In 1980, over 100,000 accessions were sent from the NPGS to foreign cooperators in over 130 countries. Approximately 75 percent of all additions to the NPGS are received as the result of exchange with these countries.

**Genetic diversity is available: While gaps do indeed exist [e.g., soybeans from the People's Republic of China (PRC)], U.S. plant scientists have more available genetic diversity than scientists in any other country.

Weaknesses

*No apparent strategy: There has been some coordination of collecting trips, but overall coordination of acquisition efforts has been lacking. Among the

contributing factors are: (1) no formal assessments of genetic vulnerability, (2) very limited descriptor information (upon which to base acquisition decisions), and (3) no central coordination to develop acquisition strategy.

Slow to react: The system reacts slowly, even after needs are identified. Needs are often identified within a commodity (user) group which may have a poor understanding, and poor communication with, those units involved in acquisition. Again, no one individual is charged with coordinating these efforts.

*Lack of trained collectors: A plant collection expedition may focus on one genus or species, with peripheral interest in other species, or it may target numerous species for collection. In either event, the success of the expedition is heavily dependent upon the abilities of the collectors. Plant exploration has so little visibility that few scientists are receiving adequate training in this field. PIO and/or State Department briefings immediately preceding explorations are also less comprehensive than would be desirable.

***Too few collecting trips: Many important centers of origin are facing immediate threats to their native plant populations due to man's encroachments. Neither planning nor resources are adequate to provide the expeditions needed to salvage critically needed germplasm from these areas.

Limited by regulation (quarantine): Acquisition efforts within the NPGS are hampered by quarantine regulations. While recognizing the value of an effective quarantine system, the acquisition objectives of the NPGS may be counter to the regulations of APHIS. Prohibited materials (e.g., corn, sorghum, wheat, potatoes, fruits) may not enter working collections or research programs until they have cleared quarantine, a period of 1 to several years. The NPGS does

not have routine systematic quarantine procedures in effect for some crops such as corn and sorghum. Joint planning and procedures between NPGS and APHIS are lacking in many areas.

<u>Problems identifying requested domestic material</u>: The PIO often receives requests for domestic material which is not readily identifiable within the NPGS and excessive time is required to respond. This lack of a systematic procedure for incorporating domestic material into the NPGS is a serious problem which is discussed further on page II-7.

B. WORKING COLLECTIONS

Strengths

Technology exists to have excellent facilities: Current technology provides the capability to plan and construct excellent seed-storage facilities. Future construction and renovation incorporating these technologies will provide optimal storage facilities for the foreseeable future.

Collections within the system are secure: The NPGS monitors known collections with the objective of protecting the collections in the event of curator death, disability, or reassignment or adverse administrative decisions.

*Recognition of importance: The working collections are the most visible component of the NPGS and, as such, they have received very strong support from the user community. These supporters have also recognized the need for a strong total NPGS. The importance of these collections has been further recognized by the Joint Council on Food and Agricultural Sciences (JC), the National Agricultural Research and Extension Users Advisory Board (UAB), GAO, and such commodity groups as the National Oat Improvement Council (NOIC) and the National Wheat Improvement Committee (NWIC).

***Heavy use: The working collections of the NPGS support the entire crop improvement program and are essential to continued increases in productivity. The tens of thousands of samples distributed annually--see page I-15 of The National Plant Germplasm System: I. Current Status (1980)--attest to the value of these collections.

Material is readily accessible: The curators of the working collections recognize their obligation to make small samples of accessions within the collections readily available to the user community.

****Material is free to users: Distributing accessions to users without charge facilitaties the flow of germplasm and is thus essential to fulfilling the mission of the NPGS.

Weaknesses

Inadequate grow-out procedures: Although grow-out (replenishment) needs vary between crop species, there is a need for a more systematic grow-out policy. Some accessions are in danger of being lost by being repeatedly omitted in grow-out plantings.

Lack of succession policy for some curators: The question has been raised, "Is even the Federal Government secure enough to entrust with so precious a resource as plant germplasm?" Nevertheless, succession is considered to be most certain if curators have an identifiable curatorial job description and are associated with the NPGS as Agricultural Research Service (ARS) employees. The next most secure arrangement involves Federal NPGS funding through cooperative agreements. A number of important collections, however, are managed by curators who have neither of these relationships. No matter how great the dedication of these individuals, the guarantee of continued support or of their succession is a matter of national concern.

*Inadequate facilities: The security of a working colletion is limited by its storage facilities, and some collections (e.g., small grains and soybeans) are stored under less than ideal conditions.

****Insufficient descriptor information: Use of the collections is severely limited by a lack of descriptor information. This lack of information forces users to either limit their requests to the best known accessions or to request large numbers of accessions to screen themselves.

Redundancy among collections: Although this problem is being addressed by the regional plant introduction station (RPIS) curators, there remains the problem of more than one RPIS maintaining the same accession.

*Seed viability not adequately monitored: Current policies and resources do not allow for routine sampling and testing for seed viability. This issue is especially critical for those collections which are not currently on a regular grow-out schedule.

***Curator role poorly defined: (See page II-22.)

*Regional perspective of curatorial units: Since line management is organized on a regional (ARS) or State basis, it is not always recognized that each curatorial unit is independent and completely national in scope concerning those crops for which it is assigned maintenance responsibility.

Impact of Plant Variety Protection Act: The Plant Variety Protection Act (PVPA) has resulted (for at least some crops, e.g., small grains) in plant breeders being less willing to enter advanced breeding lines in the germplasm collections. This appears to be due to the fact that the collections are "open stock" and accessions are available to any bona fide researcher. If correct, this is an unfortunate situation about which the NPGS can do little, but which may merit attention by those evaluating the impact of the PVPA.

***Omissions of domestic material in most collections: Most of the working collections do not include domestic advanced lines or cultivars. The need for such materials is presented on page I-24 of The National Plant Germplasm System: I. Current Status (1980). This is the most heavily used portion of those collections in which these materials are included.

Limited maintenance research: There is a paucity of research upon which curators can draw relative to maintenance techniques and strategies. Decisions are made with regularity, which influence the amount of genetic drift which may take place within an accession. Optimal isolation is not always possible for cross-pollinated (or partially cross-pollinated) species. Additional maintenance research is needed to assist curators in these types of decisions.

**Not all "major" collections have full-time curators: Several "major" collections do not currently have full-time curators. NOTE: A "major" collecton is determined by the value of the crop in combination with the projected size and complexity of the collection. The lack of a full-time curator impacts upon both the security of a collection and its potential for evaluation and use.

C. BASE COLLECTION

Strengths

*Effective seed storage: The National Seed Storage Laboratory (NSSL) provides safe seed-storage capabilities with no seed being lost due to poor germination.

Strong research program: The NSSL research effort has provided the best information available on the long-term preservation of seed. This research effort is unique in that a broad range of species are studied, and that preservation research encompasses much longer periods than are studied elsewhere.

National recognition: The NSSL, and also the World Collection of Small Grains, are widely recognized as national facilities. The RPIS's also have national responsibilities although they are sometimes (incorrectly) thought of as having only regional missions.

Weaknesses

****Lack of space: The NSSL is badly in need of additional space. Space is not available to store all accessions which should currently be cataloged at NSSL.

***Coordination with working collections: Many of the working collections are not "backed-up" with storage samples at NSSL. Out of approximately 22,000 accessions at the NC-7 RPIS, only 5,466 are cataloged at NSSL. Unfortunately, this situation is not unique. Very few of the approximately 82,000 accessions in the World Collection of Small Grains are cataloged at NSSL, although all are stored in unopened boxes. Meaningful plans to construct new facilities for NSSL cannot be completed unless closely coordinated projections of storage needs can be developed, which would, hopefully, provide back-up storage for all working collections.

Effects of sample size and storage containers on space needs: The NSSL originally stored seed in one-pint metal containers. Significant space is being saved as these cans are being replaced by flexible containers. Considerably more space might be conserved if sample sizes were reduced. Such a change would also assist the curators of working collections who may have great difficulty making larger quantities available at NSSL.

D. USERS OF THE NPGS

Strengths

**<u>User community is diverse</u>: The user community associated with the NPGS is extremely diverse. It includes Federal, State, industry, and foreign components. It includes a large component involved in plant breeding and productivity research, but it also includes scientists in the most basic biological sciences. Many of the users actually contribute germplasm back into the system and the user community plays a major role in the evaluation of germplasm. The working strength of the user community obviously varies with the talents of the individuals and the support they are receiving. The objectives of the users are likely to be at least somewhat coordinated within a commodity, pest, or discipline area, but they are unlikely to be coordinated through the NPGS organizational structure. This is a traditional approach to agricultural research in this country, which has an outstanding record of achievement.

Weaknesses

***<u>Lack of communication</u>: Users are often unaware of additions to collections, descriptor information which may be available, sites for and timing of grow-outs, evaluations needed, or any number of other pertinent facts relating to the NPGS. Communication mechanisms to provide these kinds of information are currently lacking.

*<u>Inefficient use of germplasm collections</u>: Users will often request and screen large portions of a collection because there is insufficient descriptor information to allow them to choose accessions more discretely.

*<u>Insufficient germplasm enhancement efforts</u>: Many of the most needed genetic traits occur in otherwise undesirable germplasm. There is a real need for

additional support of germplasm enhancement efforts, which would be directed toward incorporating these traits (individually or in combination) into adapted types with high potential as parents.

***<u>Genetic vulnerability not adequately assessed</u>: Vulnerability is a very complex issue which is often oversimplified (see section V.A.). Suffice it to say that the user community has not always implemented the strategies necessary to adequately assess vulnerability. Reactions to vulnerability problems have generally been on an ad hoc basis. Without adequate assessments of vulnerability, unidentified gaps may continue to exist in the collections.

<u>Insufficient feedback from users</u>: Most users of the NPGS obtain information on the materials they use. However, the system has not provided sufficient mechanisms and/or motivation to obtain significant feedback of this information into the system.

E. INFORMATION MANAGEMENT

Strengths

****Information-management system is being implemented: The implementation of a systemwide information-management system offers great potential for the NPGS. The decision to pursue this course was, indeed, farsighted.

*Data are being processed: Due in large measure to the recognition of need for and support of the user community, data are being processed at the sites of individual NPGS components. This strong base of support, interest, innovation, and need from both the supply and demand sides of the NPGS should be a great asset in implementing an information system.

Weaknesses

Data not perceived as a system resource: Although the need for additional data, or additional power to manage data, has been recognized by individual components of the NPGS, the concept of data as a manageable resource of the system is just emerging.

**Lack of perception of potentials of information management: Some modern concepts of information management are unfamiliar to many participants in the NPGS. This makes it difficult for these individuals to appreciate the total potential of such a system. It also makes it difficult for them to effectively review information-management proposals. Every effort must be made by both information specialists and germplasm specialists to overcome serious communication problems.

****Lack of descriptor information: Major efforts will be needed to obtain the descriptor information needed to fully utilize existing collections and to recognize gaps which may exist within them. Any information system will be of

limited value until this descriptor information is obtained. It should be noted, however, that development of the information system and evaluation of descriptors are integrated activities.

Section III.

MANAGEMENT COMPONENTS

Strengths

*Commitment of managers and operators of NPGS: The most perfectly structured management scheme will fail if it is not managed and operated by people committed to the objectives of the organization. The NPGS is operated by scientists with a long-standing commitment to the importance of germplasm and there now exists a strong recognition of the value of this precious resource within the many management components of the NPGS. This commitment is essential and is, indeed, a strength.

Weaknesses

***Unclear lines of authority: Although the NPGS is dependent upon cooperation among Federal, State, and private components, the key administrative elements are within S&E-ARS. The current organizational structure of ARS is perceived by many to have too many lines and levels of authority to provide adequate administration of a national program such as germplasm. A visible central staff position does exist (Assistant to the Deputy Administrator for Germplasm), but line authority rests with regional and area administrators. Conflicting priorities and philosophies are a reality which must be addressed. Conflicting priorities may also arise between the "supply side" of the NPGS (NRP 20160) and the "demand side" [as represented by other National Research Program Leaders (NRPL's)]. The most important step in minimizing these problems is to recognize they may exist.

***Autonomy of State programs: The strong desire of State agricultural experiment station (SAES) directors for autonomy in the expenditure of funds administered through Cooperative State Research Service (CSRS) serves as an impediment to

effectively directing and coordinating Federal appropriations to State projects associated with the NPGS. It is especially difficult to coordinate germplasm evaluation efforts through the CSRS/SAES structure.

**Curators lack technical guidance: Crop advisory committees (CAC's) have provided a mechanism which enables curators to interact with the user community and gain their technical inputs. Most curators do not, however, have an adequate source of technical guidance which is regularly available to them.

***Inadequate recognition of service activities: The current management system (especially within ARS) has not adequately rewarded the contributions of service activities as opposed to research contributions. It is the responsibility of Government to provide services and the NPGS constitutes one of the most valuable services to our agricultural production system.

*Lack of accountability: Management has the prerogative (in fact, the responsibility) to make policy decisions and determine resource allocations which can have a great impact on program operation. A corollary responsibility is that this decision process be visible. The level at which decisions are made is often so obfuscated that accountability is lost. This weakness is not unique to the NPGS, but it is especially critical because of the breadth of the program.

Section IV.

ADVISORY COMPONENTS

Strengths

***Creation of CAC's: The addition of CAC's as an advisory component of the NPGS has contributed greatly to the coordination and communication between the supply and demand sides of the system.

Participation increases commitment: Participation on any of the advisory bodies within the NPGS sharpens one's awareness of the value of the system. These participants generally become excellent ambassadors for the NPGS.

Weaknesses

**Incomplete representation on key NPGS committees: Membership on both the existing and proposed National Plant Germplasm Committee (NPGC) is tied closely to the operation of the RPIS, while major NPGS elements; e.g., the World Collection of Small Grains, NSSL, the soybean collection, and the clonal repositories; are poorly represented on either the NPGC or on other ad hoc committees.

**Committee roles are poorly defined: Administrative reorganizations, committee restructuring, and the appearance of ad hoc committees to address specific issues has created confusion as to the function of the various advisory components. A clear understanding of composition, responsibilities, guidelines, and limitations of these components is lacking throughout the NPGS.

Section V.

SPECIAL TOPICS

A. VULNERABILITY

Much discussion of the NPGS has been related to the issue of "vulnerability." Misuse and misunderstanding of the term and well-meaning oversimplification of the issue have created an atmosphere of confusion and, sometimes, distrust. This brief section is intended to provide a working understanding of the different kinds of vulnerability and how they relate to the NPGS.

The first need is to define vulnerability. The term relates to a susceptibility to injury, which may result from disease, insect, or weed pests or from adverse environmental conditions. Levels of vulnerability to individual sources of damage are generally independent.

The broadest form of vulnerability is crop vulnerability. This relates to the crop being grown by farmers in any specified area. A crop may be vulnerable because too few species are grown or because there is too little genetic diversity among cultivars within a crop species. Numbers of cultivars (within a species) grown in a given area do not provide a clear-cut assessment of vulnerability. Five cultivars carrying the same source of disease resistance are more vulnerable to that disease than a monoculture of a cultivar with multiple sources of resistance to the same disease. Crop vulnerability can be monitored by extension specialists, research scientists, or other competent individuals with knowledge of the specific pest or environmental condition in question. Such assessments are beyond the scope of activities generally undertaken in the NPGS.

Genetic vulnerability is a more narrow term relating to the genetic makeup of an accession, or collection of accessions. In relation to the NPGS, it could be used in reference either to advanced breeding material or to an entire germplasm collection. The southern corn leaf blight epidemic was a situation where the crop was vulnerable but resistance was available in advanced breeding material. Eastern wheat workers, on the other hand, are faced with a problem, glume blotch, where all advanced material is vulnerable to the disease and no good source of resistance has been identified in the germplasm collection. This latter case is an example of a known gap in the collection. The lack of descriptor information available within the NPGS suggests that unknown gaps also exist.

It is important to note, however, that when pests (or conditions) have been recognized as being serious enough to warrant significant expenditures of research funds; coordinated, multidisciplinary efforts have traditionally been mounted to address the problems. These efforts have been systematic and the participating scientists have been acutely aware of the need for diverse sources of resistance. A few examples of vulnerability problems which have been addressed by coordinated programs are: crown rust (oats), leaf rust (wheat), European corn borer (corn), barley yellow dwarf virus (cereals), cereal leaf beetle (cereals), cyst nematode (soybeans), glume blotch (wheat), alfalfa weevil (alfalfa), and aluminum toxicity (barley and wheat).

Those situations where genetic vulnerability exists are usually recognized by scientists in the user community. Their ability to address these issues is dependent, though, upon priorities imposed by management. Both S&E-ARS and

SAES appear to be giving lower priority to the kinds of programs which have traditionally addressed problems of vulnerability, but the levels at which these management decisions are made is often obscure.

B. SERVICE FUNCTIONS

This section addresses an issue which is alluded to in other portions of this report. It is an issue which is generally ignored, but which may be the most critical facing the agricultural research establishment of this country. It can be stated very simply: Are ARS and SAES giving adequate support and recognition to service functions?

Among the working components of the NPGS; the PIO, the working collections, and the base collections would all be service functions. Many of the activities of the user community (such as evaluation and germplasm enhancement) would also be service oriented, as is the information-management component.

The peer review system for evaluating Federal scientists has evolved in such a way that these types of service activities do not receive high ratings. Administrators are understandably anxious to administer highly esteemed programs, so they also support more basic endeavors. When service activities are supported, they are often "smuggled" under more glamorous guises and the word, service, is carefully avoided.

One curator asked, "In terms of peer evaluations and reviews, who really are our peers?"

Questions which must be asked (and answered) by agricultural administrators are, "Isn't it the responsibility of Government to provide services?" and "Are we abdicating that responsibility?"

C. CURATOR ROLE

The curators of the various collections within the NPGS are the very heart of that system. Many of them manage major facilities and sizable groups of workers, all are entrusted with the protection and preservation of a precious resource, and they must effectively interface with all other elements of the NPGS.

The LRP-NPGS (Part III of this document) must address these major issues:

1. Greater rewards and support for curators--The curators play the key role in the NPGS; their work is essential and demanding, and it is imperative that they be rewarded if the NPGS is to attract and maintain strong individuals in these positions.
2. Definition of curator role--The NPGC has approved a detailed statement of the curator's role and responsibilities. This will require only minor modifications to encompass the recommendations in LRP-NPGS.
3. Technical guidance for curators--The advisory relationship of CAC's to the curators has been established, but no format for technical guidance currently exists. It is extremely important that curators have a constantly available source of technical guidance to assist them in those decisions which are not properly within the curators' purview.

D. COMMUNICATION

Though an obvious part of any system, communication needs are often overlooked. Such has been the case within the NPGS. A strong communication network must be implemented if the full potential of the NPGS is to be achieved. The complexity of the system is such that a combination of communication instruments will be required.

Among the more critical lines 1/ of communication are:

1. National Program Staff (NPS)--line management
2. Technical advisors--curators
3. Curators--user community
4. Curators--PIO
5. Assistant to Deputy Administrator for Germplasm--all elements
6. Assistant to Deputy Administrator for Germplasm--other NRPL
7. Advisory components--administrators and/or curators
8. Information management--all elements
9. Among all elements within a commodity or discipline.
10. NPGS--Other action agencies [i.e., APHIS, Soil Conservation Service (SCS), Agency for International Development (AID)]

1/ A communication line must be designed to allow a two-way flow of information.

E. RESEARCH CONSIDERATIONS

Besides (and to enhance) the major service functions of the NPGS, it is essential that funding for the NPGS be sufficient to provide supporting research activities. What little research of this nature that is now funded is fragmented and uncoordinated.

A few of the topics with major research needs are: (1) ecogeographic distribution of diversity; (2) methodologies associated with collection strategies; (3) experimental evolution; and (4) maintenance methods, including cryogenic preservation.

Ecogeographic distribution of diversity

Primitive cultivars have immense ranges of differentiated agroecotypes. The distinctive characteristics of certain forms or taxa have been shaped by climatic, edaphic, and human pressures. For example, different countries and regions in the basin and islands of the Mediterranean have distinct forms within several species of wheat and its relatives. Barley yellow dwarf virus exhibits an altitudinal cline in Ethiopia with higher frequency of resistance found at higher elevations than lower ones. Plotting associations of plant characteristics with ecologically and geographically defined locations would identify areas for plant exploration and, perhaps, locales where improved plant materials might be successfully grown. Research on the genetic, ecological, and cultural conditions that led to the formation of distinct land races and primitive types is fundamental to any germplasm system.

Methodologies associated with collection strategies

Collection strategies must be based upon the distribution of sampling sites, numbers of sites, and numbers of plants to sample at each site. Theoretical

studies on genetic diversity have examined the influence of kinds of alleles and their frequencies in wild and cultivated species. Few of these, however, have addressed allelic distributions and frequencies as they relate to collecting and conservation strategies on a broad scale. Where extinction is not imminent, research on developing efficient collection methodology and rationale is indicated. Many land races of important food crops are rapidly approaching extinction, however, and in these cases, the only available strategy may be to collect as quickly as possible, but with emphasis in areas not heavily collected previously.

Experimental evolution

In contrast to the breeder, pathologist, or entomologist, who extract genes from germplasm collections for the relatively immediate needs of improved plant performance, others regard the germplasm collections per se as their experimental material. The latter include the experimental taxonomist, crop-plant evolutionist, and ethnobotanist. They continually use the germplasm collections to clarify and revise classification of plant relationships as new plant resources, new techniques, and new understanding of plant biology become available. Their studies encompass interspecific and intergeneric crosses, chromosome behavior and hybrid breakdown, use of chromosome knobs or markers to trace evolutionary pathways, plant and medicinal folklore for useful plant products, chromosomal and genome substitution, and creation of new polyploid or dihaploid forms or species, e.g., triticale.

Maintenance methods

Research indicates a wide range in the temperatures and seed moistures required for long-term preservation. Results with imbibed seeds, storage in various gas concentrations, freezing in liquid nitrogen, pollen storage, and tissue

culture have all been highly species dependent. Adequate information is available for long-term storage of many seeds, but for many other species, suitable information is lacking. Research should reveal safer and more efficient storage methods for other seeds or tissues currently difficult or impossible to maintain. Ideally, it is hoped that future technology would preclude or alleviate the need for clonal nurseries and also reduce the frequency of rejuvenation of stored seeds, pollen, or tissues.

<u>Genetic engineering</u>

The system must also be aware of, and interact with, such developing technologies as molecular genetics, tissue culture, and cell culture. Understanding the impact of these technologies is essential if the LRP-NPGS is to realistically address our long-term germplasm needs.

While developments within the broad field of genetic engineering are occurring with amazing rapidity, the application of these developments to the NPGS will be quite gradual. Projections by experts in this field indicate the advances in protoplast fusion have progressed to the point that the practical inducement of cytoplasmic male sterility (through mitochondrial transfer) might be possible in some species within a 10-year period. It is also estimated that single gene transfers (which could obviously include disease resistance) might be possible within 20 years. However, the complexity of moving large numbers of genes, such as complete metabolic pathways or the genes controlling such complex characters as yield, will probably preclude such achievements for at least 50 years. Major applications to the NPGS will also be limited by the fact that highly important regulatory genes are among the most difficult to move.

An additional benefit of the new technologies may be the use of tissue culture propagation as a sanitation measure. This technique might easily have value in the propagation of virus-free materials.

THE NATIONAL PLANT GERMPLASM SYSTEM

III. LONG-RANGE PLAN (1983-1997)

CONTENTS

List of Tables

List of Appendices

PREFACE

This report represents the final phase in the development of a long-range plan for the National Plant Germplasm System (NPGS). It relies upon information assembled and conclusions reached during the preparation of The National Plant Germplasm System: I. Current Status (1980) and The National Plant Germplasm System: II. Strengths and Weaknesses. Recommendations and budget requirements are based upon extensive consultation with the Germplasm Task Force and others associated with the NPGS, upon the Germplasm Workshop (Peoria, IL--March 9-11, 1981), and interactions with some members of the National Plant Genetic Resources Board (NPGRB) and the National Plant Germplasm Committee (NPGC).

The report presents a set of recommendations designed to address those weaknesses previously identified. Some of the recommendations imply additional expenditures, but many can be addressed with policy modifications and little or no additional cost. The report also includes budget requirements to meet the needs of the NPGS in both the short-range (1983-88) and the long-range (1989-97). All cost projections are based upon 1981 dollars.

Section I.

INTRODUCTION

The NPGS conserves and manages a vital national resource which has been too long neglected. The value of this resource has become more widely recognized and agricultural research managers now seem to have a commitment to realize the potential of this sytem. This long-range plan (LRP) for the NPGS is intended to serve as a road map for the improvement of this system.

Some of the most immediate needs, which have been identified by the task force and/or the General Accounting Office (GAO), are addressed with quite specific recommendations. Other recommendations are less specific and rely upon continuing review by advisory and management components. The recommendations are presented as an interrelated set with no priority ordering intended. It is important to note that the budget requirements are intentionally conservative (relative to the needs of the NPGS) and that many of the individual projections are coordinated with related NPGS needs and developments. It is the strong recommendation of this report that there be a continuing commitment to implement this 15-year plan as a total package.

Section II.

RECOMMENDATIONS

A. WORKING COMPONENTS

Plant explorations and exchanges are the foundation upon which the NPGS is built. These acquisition activities must, however, be guided by sound strategy and effective coordination. More ecogeographic research is needed, and this must be coordinated with assessments of genetic vulnerability, inputs from crop advisory committees (CAC's), and major evaluations of existing germplasm collections to better determine acquisition needs. Once these requirements are identified, they must also be communicated to those with the capabilities necessary to conduct explorations or arrange exchanges. Unfortunately, too few people are currently trained in either ecogeographic research or plant exploration.

The current system of reviewing proposals for Agricultural Research Service (ARS) support of exploration (first within regions and then nationally) has probably worked well as a system of review, but the associated concept of funding by regions is without justification. Acquisition of plant germplasm is a national responsibility requiring national attention.

- Rec. A-1--Funding for ARS-supported plant explorations will be budgeted through the Plant Exploration Office, which will be a part of the Economic Botany Laboratory (EBL).

- Rec. A-2--Proposals for ARS funding of plant explorations will be solicited (through the regional technical committees) and reviewed by a new committee: the National Plant Exploration Committee (NPEC)--see table 1.

Table I. Proposed Membership of National Plant Exploration Committee 1/

Assistant to the Deputy Administrator for Germplasm--Chairman
Plant exploration officer 2/--Executive Secretary
Plant introduction officer
Representative from NPGC
Panel 3/
National technical advisors
Curators
(Crop advisory committees) 4/

1/ This committee will meet annually to review proposals for ARS funding of plant explorations.

2/ The plant exploration officer will be assigned to the Economic Botany Laboratory (EBL).

3/ National technical advisors (NTA's) and curators will serve as a resource panel, attending only those meetings at which one or more proposals will be considered involving those species for which they have responsibility.

3/ Representatives of the crop advisory committees (CAC's) will not regularly attend these meetings but, in those cases in which more than one proposal has been submitted relating to a given crop, the Executive Secretary will solicit a ranking from the appropriate CAC prior to the NPEC meeting.

- Rec. A-3--Higher Education (HE) funded fellowships and/or strengthening grants will be utilized to provide graduate and in-service training in the fields of ecogeographic research and plant exploration.

The Plant Introduction Office (PIO), the working collections, the National Seed Storage Laboratory (NSSL), and the user community must interact smoothly and effectively if the NPGS is to function to its full potential. This interaction can be facilitated by the establishment of clearly defined, widely understood rules and relationships.

- Rec. A-4--The working collections will provide the primary interface with the user community. Requests for seed will be channeled through the working collections and seed from domestic sources will enter the system through the working collections.

- Rec. A-5--Regional plant introduction stations (RPIS's) will eliminate, within a 12-month period, duplications which may exist between their collections.

- Rec. A-6--Working collections will include foreign acquisitions, wild relatives, and domestic cultivars, plus some advanced breeding lines (as per recommendations from NTA's and/or CAC's).

- Rec. A-7--Within 2 or 3 years, all accessions in working collections will also be cataloged and maintained at NSSL.

The size and/or complexity of some collections is such that they can best be handled separately from the RPIS's--potatoes and small grains are examples. These collections have individual curators, but they are an integrated part of

the NPGS. Collections of a few other major crops are somewhat on the periphery of the NPGS. In some cases, one or more collections are maintained by "part-time curators" and in other cases part of a collection is maintained at an RPIS and other parts by part-time curators. Specific recommendations for certain crops should serve as guidelines (to CAC's and the NPGC) for comparable situations which will most likely arise within the projection period of this report.

- Rec. A-8--One individual will be responsible for all collections of a given crop. That individual may be the coordinator of an RPIS or someone independent of the RPIS's, but in an identifiable curatorial position. A curator may delegate responsibilities.

- Rec. A-9--Within the 15-year period of this projection, a full-time curatorial position will be established for the soybean collection (probably at Urbana, IL).

- Rec. A-10--One individual (probably at College Station, TX) will be designated as a coordinator of the three cotton collections (TX, MS, and AZ) and planning will be undertaken to create a full-time curatorial position for cotton germplasm collections.

- Rec. A-11--Planning will be undertaken to create a full-time curatorial position for peanut germplasm. This curator will be responsible for introductions which are currently with the S-9 RPIS plus species collections, cultivars, and other domestic lines not currently held at S-9. The location of this curatorial position shall be determined by a peanut CAC.

- Rec. A-12--The sorghum CAC will closely examine the overall curatorial needs for sorghum (including sweet sorghum) and report these needs to the Assistant to the Deputy Administrator for Germplasm.

The curators of the working collections are at the very heart of the NPGS. Their role must be clearly defined and the value of their contribution must be recognized and rewarded. The "Curator Role" was defined by the NPGC in a report dated September 1980. A slightly modified version of that statement is presented in appendix A.

- Rec. A-13--Those individuals assuming curatorial responsibilities and those administrators responsible for identifiable curatorial positions will agree to fulfill the responsibilities outlined in the "Curator Role." Such agreement will be entered into with the Assistant to the Deputy Administrator for Germplasm (ARS) and the appropriate Federal and/or State administrators.

- Rec. A-14--The ARS Administrator will activate a task group with a charge that they recommend review procedures whereby regional coordinators, and other scientists with primarily management and/or service responsibilities can receive greater rewards and support for their activities.

The overriding need to better evaluate accessions within, or entering, the NPGS has been stated or implied several times within this series of reports and in previous reports. The CAC's are the source of detailed recommendations relative to the evaluation of each collection and the order in which collections are evaluated is dependent upon the budget process, with lead responsibility resting with the Assistant to the Deputy Administrator for Germplasm.

While recognizing the unique characteristics of individual collections, there is a need for policy guidelines governing replenishment (grow-out) procedures and the monitoring of seed viability. The recommendations which follow are especially applicable to the larger working collections.

- Rec. A-15--The viability of seed stocks in working collections must be monitored, but only to the degree necessary to be assured of reasonably high (75 percent of viability at time of storage) germination for the period of the replenishment cycle.

- Rec. A-16--Accessions will be replenished at least once every X number of years to insure maintenance of high-quality seed. Complete blocks of a collection will be grown in a given year (an aid to evaluation and an advantage to users), along with new entries and any accessions requiring a special increase.

  $$Y = \frac{T}{X} + N + S$$

  Where: Y = Accessions grown per year

  T = Total accessions in collection

  X = Total years in replenishment cycle

  N = New accessions

  S = Special increases 1/

- Rec. A-17--The size of increase plots will be determined by the number of plants needed to maintain the genetic integrity of the sample and by anticipated needs (users and NSSL) and costs.

  Note: Curators are only obligated to supply minimal quantities

---

1/ Some popular accessions will be increased more often than the remainder of the collection, but this is a minor adjustment which may be expected in a working collection.

of seed, but 100-200 seeds will often supply a users needs whereas 5-10 seeds may require further increase.

- Rec. A-18--The replenishment schedule will be communicated to the user community and coordinated with the appropriate CAC and NTA. Users will be encouraged to visit the replenishment site and maximum opportunity will be taken to obtain evaluation data during the regular replenishment cycle.

- Rec. A-19--Technical decisions such as randomization of the collection will be dependent upon consultation with the appropriate CAC and NTA.

- Rec. A-20--Working collections will be responsible (either directly or by contract) for all grow-outs including those required by NSSL. Budget allocations will reflect this responsibility.

The security of the NPGS is dependent upon the policies and management associated with NSSL. The projected use of this facility (see Rec. A-7) will soon require expansion (see page III-19). There is an immediate need, however, for careful examination of several policies associated with the operation of this facility.

- Rec. A-21--Representatives of NPGC will visit NSSL and provide recommendations for optimal use of space within the existing facility.

- Rec. A-22--The NPGC will solicit inputs from the Director of NSSL and from all identifiable curators in an attempt to reduce the number of seeds required in each NSSL storage sample. (Example: Curators of relatively long-lived species might be required

to submit a randomly collected bulk sample from each grow-out site from which NSSL samples were obtained. NSSL would then perform germination tests on this bulk rather than on individual storage samples.)

- Rec. A-23--New accessions will enter the NPGS by being sent either to the PIO (foreign) or to the appropriate working collection (domestic)--they will not be entered directly through NSSL. Requests to store but not catalog, other collections will be responded to based upon the advice of the NPGC.

- Rec. A-24--NSSL will (either in-house or through contracts) assume all germination testing responsibilities for the NPGS. NOTE: Responsibility to assure that germinations of all collections are monitored will, however, rest with the curators of the respective collections.

Improved communication is a major need of the NPGS. No single communication instrument is likely to meet this need so it is imperative that all elements of the NPGS have a continuing motivation to search for effective means of two-way communication. The recommendations which follow indicate a few communication devices designed to meet some obvious needs--more will be needed.

- Rec. A-25--Curators of all working collections and the PIO will generate semiannual newsletters for mailing to their respective clientele. (NOTE: For this and most other newsletters, frequency of distribution, informality, and the perception of responsiveness are more important than style or appearance.)

- Rec. A-26--Curators will take maximum opportunity to include reports in commodity newsletters.

- Rec. A-27--A meeting of a new work group--the Association of Plant Germplasm Curators (APGC)--will be held annually. This will also be a convenient time and place to hold other meetings (e.g., CAC's, NPGC, or NPEC) associated with plant germplasm. The coordinators of the RPIS's will be charged with organizing APGC. The Assistant to the Deputy Administrator for Germplasm, the Chairman of NPGC, the plant introduction officer, and the plant exploration officer will also participate as members of this Association.

- Rec. A-28--The Data Base Manager (DBM) will utilize all practical means (i.e., society newsletters, semipopular acticles, and personal appearances) to communicate the availability and potentialities of the Data Base Management System (DBMS). The DBMS will also be utilized as a communication instrument to convey timely messages to its users.

Successful implementation of the DBMS is of critical importance to the NPGS. Some of the pending decisions relative to that implementation are both difficult and important. Since these decisions are being addressed by a broadly based Germplasm Resources Information Project (GRIP) Coordinating Committee, specific recommendations relative to the DBMS implementation are not included in this report.

- Rec. A-29--The DBMS will be implemented early in FY 1983, with sufficient financial support to assure the success of this critical element of the NPGS.

B. MANAGEMENT COMPONENTS

A management system will probably be judged effective if the interrelationships between decisions are visible and coordinated and if it is readily apparent what kinds of decisions are made at what levels and upon what criteria. Judging the management components of the NPGS by these standards reveals diverse, and sometimes conflicting, lines of authority and obscure points of accountability. This judgment also reveals management's growing commitment to the NPGS and its corresponding willingness to "fine tune" the existing system to improve the NPGS. One very positive step is the willingness of high-level ARS managers to serve as members of the reorganized NPGC. While current management is developing sensitivity and commitment to the NPGS, the goal of management must be <u>to institutionalize these sensitivities and that commitment</u>.

While the regional structure and sometimes unclear line/staff relationships in ARS and the strict autonomy of the SAES directors do not seem to compliment a cooperative national effort, these problems must not be considered insurmountable. The organization of ARS can accommodate a program such as the NPGS if that program receives continued visibility and a strong personal commitment from the ARS Administrator. Also, there are research activities relating to the NPGS which can be supported through CSRS.

The elevation of the ARS Germplasm Coordinator to the position of Assistant to the Deputy Administrator for Germplasm is significant. This position serves as the focal point for the NPGS, and it has the responsibility to assimilate inputs from the working components, advisory components, and other management components. This individual is also charged with the responsibility of making those policy decisions necessary to offer effective leadership to this national program.

- Rec. B-1--The ARS Administrator will reaffirm the leadership role of the Assistant to the Deputy Administrator for Germplasm and his involvement in budget development, program planning and review, and monitoring.

- Rec. B-2--Funding and coordination of germplasm evaluation will be through ARS. Cooperative agreements will be utilized to fund non-Federal projects.

- Rec. B-3--Germplasm enhancement efforts will receive support through both ARS and CSRS.

An interagency problem affecting the NPGS is the need for better coordination between ARS and APHIS in discussing such issues as central facilities, systematic quarantine procedures for crops such as corn and sorghum, and direct quarantine and indexing by clonal repositories.

- Rec. B-4--The Science and Education Coordination Office (SECO) will coordinate the development of an ARS/APHIS Germplasm Oversight Committee. This body will have a continuing responsibility to encourage and facilitate cooperation between these agencies in all matters relating to germplasm.

C. ADVISORY COMPONENTS

A major strength of the NPGS is the structure of advisory components and the generally close relationship of these components to management. It is important to note, however, that none of these advisory units establishes policy (although several advise on, and strongly influence, policy matters). It should not be their objective to establish policy (because they cannot assume the associated accountability), but rather to maximize their influence by enhancing their reputations for providing sound counsel.

The NPGS is currently enjoying some increased visibility after many years of relative neglect. While the Nation's germplasm needs will continue, this level of visibility may be transitory. The NPGRB is one of three advisory bodies 1/ associated with Science and Education (S&E), which advises the Secretary of Agriculture, and it can play a vital role in providing important policy advice at the highest levels of USDA management. This body has the potential to identify problems, needs, and opportunities associated with the NPGS; to determine goals for the NPGS; and to review options for reaching those goals.

The NPGRB cannot hope to operate with full effectiveness unless it receives adequate staff support. While other comparable boards are supported by full-time dedicated staff positions, the Executive Secretary of the NPGRB must attempt to fulfill his role while still meeting a multitude of more primary responsibilities.

- Rec. C-1--The NPGRB merits and will receive at least half-time support from a dedicated staff position. This primary support position

---

1/ Others are the Joint Council on Food and Agricultural Sciences (JC) and the National Agricultural Research and Extension Users Advisory Board (UAB).

will provide secretariat services to the NPGRB and will have access to sufficient funding to support NPGRB activities.

There are many technical decisions affecting both the working collections and the base collection which may not be in the curator's area of training or which, more probably, would be inappropriate for a curator to make. The regionalized management structure of ARS does not provide technical guidance in these areas and the National Research Program Leaders (NRPL's) generally have such broad responsibilities that they cannot effectively serve this function either. The CAC's are an important element of the current NPGS which provide this type of guidance 2/. CAC's are formed when a crop is deemed to have sufficient need by the NPGRB and when the scientists associated with that crop show sufficient organization and interest to select such a committee.

While the CAC's have proven to be an especially valuable addition to the NPGS, they are limited by time and resources from providing the immediate responses needed to assure effective technical guidance on a continuing basis.

- Rec. C-2--A national technical advisor (NTA) will be designated, within ARS, for each crop having a CAC. The criteria used in establishing CAC's should prove equally valid in judging the need for NTA's. Besides serving on their respective CAC's and providing technical guidance to the NPGS, these individuals will provide the leadership, guidance, and liaison so often called for by the scientists (Federal, State, and private) involved in the continuum of productivity research.

2/ NSSL receives technical guidance from the NPGC.

The CAC's are an essential link between the user community and other working components. They also link the user community to other advisory components in the NPGS. It is of critical importance that existing CAC's continue to operate effectively and that new CAC's come into operation as needs arise.

- Rec. C-3--Although "owned" by their respective user communities, the CAC's will be facilitated by a carefully selected individual operating under the direct supervision of the Assistant to the Deputy Administrator for Germplasm.

D. FACILITIES

The most immediately needed facility in the NPGS is a new building to house the Small Grains Collection. Renovations to the old facility have quelled some fears for the actual safety of the collection, but the current facilities remain woefully inadequate. The Small Grain Collection is the largest, and most used, working collection in the NPGS. The choice of a location for a new facility to serve that collection (or any other collection) must be based upon criteria which are both clear and simple. The principal criteria are: What location will best assure the safe maintenance of that collection and best serve its users? Addressing these criteria necessarily requires addressing a number of factors which are specific to that collection 1/. The recommendation relative to the location of the Small Grain Collection is based upon consideration of the following factors.

(1) Only four locations were considered to be possibilities:

(a) Beltsville, MD--The current site

(b) Pullman, WA--Suggested by a committee prior to the Beltsville renovations

(c) Aberdeen, ID--The prime grow-out location 2/

(d) Fort Collins, CO--In the event NSSL should be moved

(2) The Plant Genetics and Germplasm Institute (PGGI) is planning a "Plant Germplasm Center" with the intention of including the U.S. Plant

---

1/ Similar crop-specific assesments may be called for in response to recommendations A-9 through 12. The Assistant to the Deputy Administrator for Germplasm will, along with the NPGC, look to appropriate CAC's as the primary source for these inputs.

2/ Mesa, Arizona (the other grow-out location) was not considered due to the probability of future water shortages and urban encroachment.

Introduction (quarantine) Station, the Plant Introduction Office (PIO), the Data Base Management Unit, the Plant Taxonomy Laboratory (PTL), the EBL, and the proposed new Small Grain Collection facility.

(3) The current management at Beltsville seems committed to a strong germplasm program.

(4) There seems to be little justification for moving NSSL from Fort Collins.

(5) The consistently high-quality of seed produced at the grow-out locations (Aberdeen, ID, and Mesa, AZ) is a major strength of the Small Grain Collection.

(6) Associating the Small Grain Collection with any one of the already heavily worked RPIS's would serve no real purpose and would greatly imbalance the responsibiities of the four RPIS's.

(7) There is probably no significant difference between the locations in long-term staffing potential, although there have been some problems in recruiting for the Beltsville area.

(8) Construction costs are especially high in the Beltsville area.

(9) Travel restrictions have become a very real factor, and travel costs would be much reduced at the Aberdeen location.

(10) The curator has not been able to give adequate attention to the collection during grow-outs under the existing arrangement.

(11) The evaluation needs of the Small Grain Collection are immense, and the process of evaluating both current and incoming materials will be a

continuing responsibility. Thus, there will be a continuing need for the curator (and any others assigned to this project) to devote more time to the collection during grow-outs.

(12) Aberdeen is closely identified with the Small Grain Collection by the user community. It offers a nearly ideal climate for small grain seed production and has a long history of effective and enthusiastic cooperation in such endeavors. There is also a "critical mass" of small grain research at that location.

(13) Land, equipment, and technology for seed increase already exist at Aberdeen.

(14) The Small Grain Collection was originated and closely monitoried by investigation leaders (prior to 1972), and the Beltsville location offered the opportunity for a close liaison between the investigation leaders and the curators. They also spent considerable time together at Aberdeen.

(15) There would appear to be little justification, under present circumstances, to separate a curator and maintenance facilities from a major grow-out location.

- Rec. D-1--A new facility will be built at Aberdeen, ID, which will house the staff associated with the Small Grain Collection and provide space and equipment to process, evaluate, maintain, and manage the Collection.

- Rec. D-2--A "Germplasm Center," housing the U.S. Plant Introduction (quarantine) Station, the PIO, the Data Base Management Unit,

the EBL, and the PTL will be constructed at Beltsville, MD (collocated with the APHIS facility presently under construction in BARC-East).

The National Coordinating Committee for the New Crops Program appointed a subcommittee, at their 1949 meeting, to study the national needs for seed storage. That subcommittee reported February 27, 1950, and presented a strong case for the construction of a national seed-storage facility at Fort Collins. The report of the October 15-16, 1980, meeting of the NPGC Subcommittee on Site Selection and Facility Requirements for the National Seed Storage Laboratory is included in appendix F of the National Plant Germplasm System: I. Current Status (1980). This recent document recommends expansion of the present facility, rather than gaining needed space at a new site. While there has been some recent speculation about the feasibility of a new location or utilizing salt mines for seed storage, there seems to be no compelling justification to abandon the very satisfactory Fort Collins location.

- Rec. D-3--Additional space which is needed for NSSL will be gained by expanding the present facility.

E. IMPLEMENTATION

The recommendations and budget requirements contained herein have been formulated in an atmosphere when a broad array of sources (USDA, GAO, OMB, JC, UAB, Congressional committees, SAES administrators, and others) have expressed interest in the needs and problems of the NPGS. While this document presents a plan to address these needs and problems over a 15-year period, it is unlikely that the NPGS will maintain this level of visibility for that time period. It is important, therefore, that there be a mechanism to assure the continued consideration of this plan.

- Rec. E-1--There will be an annual meeting (in January) with the Assistant Secretary for S&E 1/ to discuss the budgetary status of the NPGS. This meeting will be arranged by the Executive Secretary of the NPGRB (see Rec. C-1) and those attending will include: (1) the Vice-chairman of the NPGRB, (2) the Chairman of the NPGC, (3) the Assistant to the Deputy Administrator for Germplasm (ARS), and (4) the Executive Secretary of the NPGRB.

To further assist in the implementation of this plan, table 2 provides an indication of primary and secondary points of responsibility associated with implementation of the preceding recommendations. While primary action points are indicated, the success of this plan will really depend upon unified support by all management, advisory, and working components of the NPGC.

1/ It is assumed that the Assistant Secretary for S&E will serve as Chairman of the NPGRB.

Table 2. Implementation Guide: Showing Primary (1) and Secondary (2) Responsibility for Implementation of Recommendations

	Points of Implementation									
Recommendation	S&E Dir.	ARS Adm.	CSRS Adm.	Asst. to Dep. Adm. Germplasm	Line Mgt.	NPGRB	NPGC	Appr. CAC	Appr. NTA	Appr. Working Component
A-1				1						
A-2				1						
A-3	1			2						
A-4				2						1
A-5				2						1
A-6				2				2	2	1
A-7				2			2			1
A-8				1				2	2	
A-9				1				2	2	
A-10				1				2	2	
A-11				1				2	2	
A-12				1				1	2	
A-13				1						
A-14		1			2					
A-15										1
A-16								2	2	1
A-17								2	2	1
A-18										1
A-19								2	2	1
A-20				1						1
A-21							1			
A-22							1			2
A-23							1			1
A-24										1
A-25										1
A-26										1
A-27				1						1
A-28										1
A-29		1		1						
B-1	1	1	1							
B-2	1	1	1							
B-3	1									
C-1	1									
C-2		1								
D-1		1								
D-2		2								
D-3		1					2			
E-1	1			2		1	2			

Section III.

BUDGET REQUIREMENTS

A. Rationale

Whether rightly or wrongly, it is difficult to separate planning from the "budget process." A complete understanding of the rationale associated with the development of the budget requirements projected herein is thus essential.

The first report in this document (The National Plant Germplasm System: I. Current Status 1980) indicates a rather simple system; composed of working, management, and advisory components; which was developed in an orderly fashion by some insightful, dedicated individuals. The activities of this system form a continuum from the time germplasm is acquired (through introduction, exploration, or from breeding programs within the system), through the maintenance and evaluation of the germplasm, and on through germplasm enhancement efforts and its ultimate benefits to the user community.

The second report (The National Plant Germplasm System: II. Strengths and Weaknesses) highlighted some of the strengths of this system, but it also indicated operational and managerial flaws which limit the effectiveness of the system. This report, and also the first report, emphasize that an effective NPGS is essential to improved crop productivity. They show, however, that the NPGS lacks greatly the level of support necessary to fulfill its role in the total continuum of elements contributing to crop productivity, which were described in Plant Genetic Resources, Conservation and Use (often referred to as "the Red Book").

The first portion of this report presents discussion and recommendations intended to either correct operational and/or managerial flaws or to provide

mechanisms to minimize the occurrence of such flaws. The budget requirements projected on the following pages address the budgetary needs of the system.

Of the eight "key objectives" utilized in the recurring portion of the budget tables, the first five (acquisition, maintenance, evaluation, germplasm enhancement, and research on the conservation of genetic diversity) form the basic continuum of NPGS activities. The last three (information management, monitoring genetic vulnerability, and training) are areas essential to the support of the system.

The planning considerations upon which these budget requirements were determined are as follows:

- (1) One method by which current managers can "institutionalize" (see page III-12) their current level of interest in the NPGS is to recognize that this is, indeed, a priority area which is far from the budgetary base needed to fulfill its mission. Their goal should be to capitalize on the current level of interest in the NPGS and significantly increase the budget base in the next few fiscal years. NOTE: The actual 1982 base support for the NPGS is about $12.9 million rather than the $19.3 million indicated in table 2. The discrepancy occurs because new crops and narcotics research are included in the germplasm budget.

- (2) Sufficient funding must be made available to meet immediate exploration needs, especially in those habitats where man's encroachment may offer an immediate threat to native germplasm.

- (3) The long-range effectiveness of the NPGS will depend upon the more immediate strengthening of the maintenance and evaluation portions

of the NPGS continuum, plus the information management and training components which support the system.

- (4) While the system does monitor genetic vulnerability (in relation to germplasm enhancement and other activities), no formal base currently exists for these activities. If these kinds of activities are to be supported as a separate entity, a budget base must be established to support them.

- (5) Germplasm enhancement, research on conservation of genetic diversity, and acquisition are activities of immediate importance, but it is especially important that their long-range value be recognized. These are activities which will benefit from the early expenditures for maintenance and, especially, evaluation. Therefore, support of these activities becomes an ever-increasing part of the budget requirements during the period of these projections.

- (6) It is important to recognize which components of the State/Federal (and sometimes private) partnership can best perform these key objectives, and through which agency they can most effectively be funded. The general relationships which exist are:

    (a) Acquisition is primarily a Federal activity (although State and private scientists may perform a significant amount of exploration), but most acquisition activity should be funded through ARS.

    (b) Maintenance is a national responsibility which should be, and usually is, managed and funded by ARS.

(c) Evaluation is a broad responsibility encompassing scientists from all sectors, but requiring a great deal of control. This activity must be funded through ARS, although much of this expenditure will be extramural.

(d) Germplasm enhancement is also a broad responsibility encompassing scientists from all sectors, but it is at this point in the continuum that State scientists begin to play the more major role. These activities are well-suited to the less accountable (but not necessarily less efficient) Hatch funding.

(e) The same comments apply to research on the conservation of genetic diversity as apply to germplasm enhancement.

(f) Information management is a Federal responsibility.

(g) Monitoring genetic vulnerability is a broad responsibility which requires cooperation among ARS, SAES, and ES workers.

(h) There is a critical training need within the NPGS, and the task force recommends HE as the primary funding source.

- (7) The NPGS has certain minimal facilities needs which must be met to support the expanded system.

The budget requirements projected in this report are not inflated. In fact, they become quite modest after the first few years. It must be recognized, however, that the levels of support indicated may not always be met (or, perhaps, not in the time frame recommended). In such an event, budget analysts would understandably look for priority assessments within these budget

requirements. Other than the facilities needs, which are given priority over time, it is difficult to assign priorities within the eight recurring key objectives. A reduced allotment in any given year would generally result in a proportional decrease in support of the key objectives, but with primary consideraton being given to the seven planning considerations stated above.

It is also important to note that some of the budget detail presented in table II is not realistic for dollars passing through CSRS. Such figures do, however, provide an indication of needs within the NPGS which could benefit from State expenditures and, as such, they should be helpful in the administration of these funds.

B. 1983-88

Base budget figures indicating ARS and CSRS support of the NPGS are presented in table 3. Total projected increases are outlined in table 4 and projected allotments of these increases are indicated in tables 5-10. A detailed projection of expenditures of FY 1983 increases is shown in tables 11.1-.10. All projections of expenditures for facilities assessments and construction 1/ are described in footnotes.

NOTE: All budget projections, for the periods 1983-88 and for the period 1989-97, are in terms of 1981 dollars. An additional, very real, need is for continued adjustments to both the base budget and the projected increases to compensate for current rates of inflation.

1/ Based upon Mean's Construction Guide - Building Construction Cost Data - June 1981.

Table 3. Plant Germplasm Base Program by Program Unit

Line item/funding mechanism	1980 $000	1981 $000	1982 $000
6510 CROP PRODUCTIVITY			
Plant Germplasm			
ARS:	9,510	11,385	13,641
CSRS:			
Hatch Act	2,965	3,119	3,348
1890's	385	417	476
Special Grants	--	500	940
Competitive Grants	409	409	840
Subtotal, CSRS	3,759	4,445	5,604
TOTAL, Plant Germplasm	13,269	15,830	19,245

Table 4. Plant Germplasm--Total Required Science and Education Increases[1/] ($000) by Thrust Areas, FY's 1983-88.

KEY OBJECTIVES	Fiscal Year 1983	1984	1985	1986	1987	1988	Total
1.0 ACQUISITION	200	300	400	500	300	300	2,000
2.0 MAINTENANCE	1,200	800	700	700	400	400	4,200
3.0 EVALUATION	2,500	2,000	1,800	1,000	300	100	7,700
4.0 GERMPLASM ENHANCEMENT	1,500	1,000	1,000	1,000	600	700	5,800
5.0 RESEARCH ON THE CONSERVATION OF GENETIC DIVERSITY	800	400	400	500	300	400	2,800
6.0 INFORMATION MANAGEMENT	500	300	100	100	50	50	1,100
7.0 MONITORING GENETIC VULNERABILITY	1,000	700	400	100	20	20	2,240
8.0 TRAINING	300	500	200	100	30	20	1,150
SUBTOTALS (RECURRING)	8,000	6,000	5,000	4,000	2,000	2,000	27,000
9.0 FACILITIES ASSESSMENT, CONSTRUCTION, PROCUREMENT	2,000	1,500	7,300	1,300	1,900	1,500	15,400
TOTALS	10,000	7,500	12,300	5,300	3,900	3,500	42,400

1/ Projections in terms of 1981 dollars.

Table 5. Plant Germplasm--FY 1983 Required Increases[1] ($000)

KEY OBJECTIVES	S&E TOTAL	ARS INTERNAL	ARS EXTRAMURAL	CSRS SPECIAL GR.	CSRS HATCH	ES	HE
SUMMARY							
1.0 ACQUISITION	200	150	50				
2.0 MAINTENANCE	1,200	700	300	50	150		
3.0 EVALUATION	2,500	500	2,000				
4.0 GERMPLASM ENHANCEMENT	1,500	500		200	800		
5.0 RESEARCH ON THE CONSERVATION OF GENETIC DIVERSITY	800	400		130	270		
6.0 INFORMATION MANAGEMENT	500	500					
7.0 MONITORING GENETIC VULNERABILITY	1,000	200	100	100	300	300	
8.0 TRAINING	300	50					250
SUBTOTALS (RECURRING)	8,000	3,000	2,450	480	1,520	300	250
9.0 FACILITIES ASSESSMENT, CONSTRUCTION, PROCUREMENT	2,000	2,000[2]					
TOTALS	10,000	5,000	2,450	480	1,520	300	250

1/ Projections in terms of 1981 dollars.

Table 5. Continued...

2/ Planning and construction of facility to house USDA Small Grain Collection at Aberdeen, Idaho. Facility to provide space <u>and equipment</u> to process, evaluate, maintain, and manage the collection.

14,500 sq. ft.		
5,000 sq. ft. (seed storage) @ $125/sq. ft.	=	$ 625,000
6,000 sq. ft. (laboratory) @ $100/sq. ft.	=	600,000
3,500 sq. ft. (office) @ $65/sq. ft.	=	227,500
		$1,452,500
Plus 12 percent/year escalation		369,516
		$1,822,016
Plus 10 percent for Engineering and Supervision		182,202
		$2,004,218

Table 6. Plant Germplasm--FY 1984 Required Increases[1] ($000)

KEY OBJECTIVES	S&E TOTAL	ARS INTERNAL	ARS EXTRAMURAL	CSRS SPECIAL GR.	CSRS HATCH	ES	HE
SUMMARY							
1.0 ACQUISITION	300	200	100				
2.0 MAINTENANCE	800	400	200		200		
3.0 EVALUATION	2,000	500	1,500				
4.0 GERMPLASM ENHANCEMENT	1,000	100		200	700		
5.0 RESEARCH ON THE CONSERVATION OF GENETIC DIVERSITY	400	200			200		
6.0 INFORMATION MANAGEMENT	300	300					
7.0 MONITORING GENETIC VULNERABILITY	700	200		100	200	200	
8.0 TRAINING	500				100		400
SUBTOTALS (RECURRING)	6,000	1,900	1,800	300	1,400	200	400
9.0 FACILITIES ASSESSMENT, CONSTRUCTION, PROCUREMENT	1,500	1,500[2]					
TOTALS	7,500	3,400	1,800	300	1,400	200	400

1/ Projections in terms of 1981 dollars.

Table 6, Continued...

2/ (a) Construction and equipment to satisfy immediate storage and processing needs of the soybean collection at Urbana, Illinois. $250,000

1,600 sq. ft. (seed storage) @ $125/sq. ft. + 12 percent/year escalation + 10 percent Engineering and Supervision.

(b) Construction and equipment necessary to upgrade RPIS's (four) to meet the demands of a more intensive NPGS. $400,000.

(c) An upgrading of the current computer system within the Communications and Data Services Division (CDSD) has been requested in conjunction with the Germplasm Resources Information Project (GRIP) design. This amount is designated for the acquisition of necessary hardware and software. Some of the funds may improve the telecommunications infrastructure among the extensive GRIP-user network. Remote terminals can be used in conjunction with other telecommunications devices to assist in coordination within the NPGS network. Such equipment as computer-assisted "Coordinator's Workbenches" may be used. It is expected that this may considerably reduce travel expenses. $850,000

Table 7. Plant Germplasm--FY 1985 Required Increases[1] ($000)

KEY OBJECTIVES	S&E TOTAL	ARS INTERNAL	ARS EXTRAMURAL	CSRS SPECIAL GR.	CSRS HATCH	ES	HE
SUMMARY							
1.0 ACQUISITION	400	100	300				
2.0 MAINTENANCE	700	400	200		100		
3.0 EVALUATION	1,800	800	1,000				
4.0 GERMPLASM ENHANCEMENT	1,000	300		100	600		
5.0 RESEARCH ON THE CONSERVATION OF GENETIC DIVERSITY	400	100			300		
6.0 INFORMATION MANAGEMENT	100	100					
7.0 MONITORING GENETIC VULNERABILITY	400	100		50	200	50	
8.0 TRAINING	200				50		150
SUBTOTALS (RECURRING)	5,000	1,900	1,500	150	1,250	50	150
9.0 FACILITIES ASSESSMENT, CONSTRUCTION, PROCUREMENT	7,300	7,300 [2]					
TOTALS	12,300	9,200	1,500	150	1,250	50	150

1/ Projected increases in 1981 dollars.

Table 7. Continued...

2/ Planning and construction of addition to NSSL

40,000 sq. ft.		
27,000 sq. ft. (seed storage) @ $125/sq. ft.	=	$3,375,000
9,000 sq. ft. (laboratory) @ $100/sq. ft.	=	900,000
4,000 sq. ft. (office) @ $65/sq. ft.	=	260,000
		$4,535,000
Plus 12 percent/year escalation (2 years)	=	1,153,704
Plus 8 percent/year escalation (2 years)	=	946,600
		$6,635,304
Plus 10 percent Engineering and Supervision	=	663,530
		$7,268,834

Table 8. Plant Germplasm--FY 1986 Required Increases[1/] ($000)

KEY OBJECTIVES	S&E TOTAL	ARS		CSRS		ES	HE
		INTERNAL	EXTRAMURAL	SPECIAL GR.	HATCH		
SUMMARY							
1.0 ACQUISITION	500	200	300				
2.0 MAINTENANCE	700	500	100		100		
3.0 EVALUATION	1,000	300	700				
4.0 GERMPLASM ENHANCEMENT	1,000	200		100	700		
5.0 RESEARCH ON THE CONSERVATION OF GENETIC DIVERSITY	500	200			300		
6.0 INFORMATION MANAGEMENT	100	100					
7.0 MONITORING GENETIC VULNERABILITY	100	50				50	
8.0 TRAINING	100						100
SUBTOTALS (RECURRING)	4,000	1,550	1,100	100	1,100	50	100
9.0 FACILITIES ASSESSMENT, CONSTRUCTION, PROCUREMENT	1,300	1,300[2/]					
TOTALS	5,300	2,850	1,100	100	1,100	50	100

1/ Projected increases in 1981 dollars.

Table 8. Continued...

2/ (a) Supplementary funding to complete construction at projected sites of clonal repositories. $1,000,000

(b) Remote sensing and telecommunications devices should be used to monitor germplasm for genetic vulnerability to biotic and abiotic stresses. This equipment may be used in tests with the cooperation of Extension Service (ES) field personnel. $300,000

Table 9. Plant Germplasm--FY 1987 Required Increases 1/ ($000)

KEY OBJECTIVES	S&E TOTAL	ARS INTERNAL	ARS EXTRAMURAL	CSRS SPECIAL GR.	CSRS HATCH	ES	HE
SUMMARY							
1.0 ACQUISITION	300	100	200				
2.0 MAINTENANCE	400	300	100				
3.0 EVALUATION	300	200	100				
4.0 GERMPLASM ENHANCEMENT	600	200			400		
5.0 RESEARCH ON THE CONSERVATION OF GENETIC DIVERSITY	300	100			200		
6.0 INFORMATION MANAGEMENT	50	50					
7.0 MONITORING GENETIC VULNERABILITY	20				20		
8.0 TRAINING	30						30
SUBTOTALS (RECURRING)	2,000	950	400		620		30
9.0 FACILITIES ASSESSMENT, CONSTRUCTION, PROCUREMENT	1,900	1,900 2/					
TOTALS	3,900	2,850	400		620		30

1/ Projected increases in 1981 dollars.

Table 9. Continued...

2/ Planning and construction of Plant Germplasm Center (Phase I) at Beltsville, Maryland. Facilities to house PIO, DataBase Management Unit (and computer facilities), Economic Botany Laboratory, Plant Taxonomy Laboratory, New Crops, and other activities of Germplasm Resources Laboratory.

14,300 sq. ft.		
1,300 sq. ft. (wet laboratory) @ $125/sq. ft.	=	$ 162,500
13,000 sq. ft. (office) @ $65/sq. ft.)	=	845,000
		$1,007,500
Plus 12 percent/year escalation (2 years)	=	256,308
Plus 8 percent/year escalation (4 years)	=	455,589
		$1,719,397
Plus 10 percent Engineering and Supervision	=	171,940
		$1,891,337

Table 10. Plant Germplasm--FY 1988 Required Increases[1/] ($000)

KEY OBJECTIVES	S&E TOTAL	ARS		CSRS		ES	HE
		INTERNAL	EXTRAMURAL	SPECIAL GR.	HATCH		
SUMMARY							
1.0 ACQUISITION	300	100	200				
2.0 MAINTENANCE	400	300	100				
3.0 EVALUATION	100	50	50				
4.0 GERMPLASM ENHANCEMENT	700	200			500		
5.0 RESEARCH ON THE CONSERVATION OF GENETIC DIVERSITY	400	200			200		
6.0 INFORMATION MANAGEMENT	50	50					
7.0 MONITORING GENETIC VULNERABILITY	20					20	
8.0 TRAINING	30						30
SUBTOTALS (RECURRING)	2,000	900	350		700	20	30
9.0 FACILITIES ASSESSMENT, CONSTRUCTION, PROCUREMENT	1,500		1,500[2/]				
TOTALS	3,500	900	1,850		700	20	30

1/ Projected increases in 1981 dollars.

2/ Funding to provide secure maintenance facilities for collections of genetic stocks and other non-Federal curatorial sites.

Table 11.1. Plant Germplasm--FY 1983 Required Science and Education Increases[1] ($000) within Key Objectives

KEY OBJECTIVES	S&E TOTAL	ARS INTERNAL	ARS EXTRAMURAL	CSRS SPECIAL GR.	CSRS HATCH	ES	HE
SUMMARY							
1.0 ACQUISITION[2/]							
Planning-exploration/quarantine[3/]	50	50					
Exploration expeditions[4/]	150	100	50				
TOTALS	200	150	50				

1/ Projected increases in 1981 dollars.

2/ Major crops grown in the United States came from other parts of the world. Centers of origin and/or diversity of these crops are for the most part in underdeveloped countries. Diversity is rapidly disappearing in many of these centers, because old, variable varieties or landraces are being replaced with new, more productive but less variable ones developed in the more advanced countries. It is imperative that a maximal range of germplasm of all types, whether currently considered important to agriculture or not, be collected before this diversity is lost forever.

3/ The current relationship with APHIS is quite good, but increased germplasm activity requires much more joint planning and mutual assistance.

4/ Exploration expeditions are mostly in other countries. Mutual assistance is required, and most of these funds are intended for use abroad. Several of these expeditions may be done through cooperation agreements with the host country or institute rather than by United States teams.

Table 11.2. Plant Germplasm--FY 1983 Required Science and Education Increases[1/] ($000) within Key Objectives

KEY OBJECTIVES	S&E TOTAL	ARS INTERNAL	ARS EXTRAMURAL	CSRS SPECIAL GR.	CSRS HATCH	ES	HE
2.0 MAINTENANCE[2/]							
Base (long-term) Collections:							
Regeneration	90	20	70				
Storage	80	80					
Germination Testing	70	40	30				
Information Management	10	10					
Operational Planning	10	10					
Working Collections and Curator Operations:							
Seed	640	390	150[3/]		100[4/]		
Clonal	200	150		50			
Genetic Stocks	100		50		50[5/]		
TOTALS	1,200	700	300	50	150		

1/ Projected increases in 1981 dollars.

Table 11.2. Continued...

KEY OBJECTIVE: MAINTENANCE

2/ There are two reasons for maintaining germplasm: (a) to meet the current needs of plant scientists (through active or working collections); and (b) to meet the needs of future generations (through long-term or base collections) of plant scientists, who may have entirely new sets of problems with which to deal. In both cases, maintenance must be accomplished in ways that will minimize loss of genetic diversity. These needs are met for seed and clonal germplasm and for both "regular" plant germplasm and "special" genetic stocks.

3/ Various corporations have assisted in the maintenance of plant germplasm, especially through regeneration of material. this help is expected to increase in the future. Some of these funds are expected to match private-sector contributions.

4/ An increase in germplasm activity by State scientists is expected to increase demands on the NPGS. It is hoped that Hatch-fund increases, as a result of this action, will be fed into the NPGS to partially assist in meeting this demand. Activity in genetic stocks and DNA stocks is likely to increase greatly in the future for most crops.

5/ The clonal-repository system is being developed to cover all material that is best maintained as clones (this includes material other than fruits and nuts, such as sweet potatoes, yams, bamboo, mint, etc.). The list that follows is the current suggestion for crop coverage and clonal station sites. Funds are currently in the S&E germplasm base for clonal repositories. These funds are not currently sufficient to do what is needed.

Table 11.2. Continued...

KEY OBJECTIVE: MAINTENANCE

PROPOSED CLONAL REPOSITORIES

Priority	Crops	Location
1	Small Fruits, Pears, Filberts, Hops, and Mints	Corvallis, OR
2	Stone Fruits, Grapes, Walnuts, Almonds, Pistachios	Davis, CA
3	Apples, Eastern Grapes	Geneva, NY
4	Citrus	Orlando, FL
5	Pecans	Brownwood, TX
6	Stone Fruits, Apples, Bamboo	Byron, GA
7	Avocado, Mango, Other Subtropical Fruits	Miami, FL
8	Coffee, Cocoa, Banana, Pineapple, *Hevea* Rubber	Mayaquez, PR
9	Macadamia, Tropical Fruits	Pomaoho and Kona, HI
10	Black Walnuts, Chestnuts, Hickory	Carbondale, IL
11	Dates	Indio, CA
12	Citrus	Riverside, CA
13	Sweet Potatoes	Undecided

Table 11.3. Plant Germplasm--FY 1983 Required Science and Education Increases[1/] ($000) within Key Objectives

KEY OBJECTIVES	S&E TOTAL	ARS		CSRS		ES	HE
		INTERNAL	EXTRAMURAL	SPECIAL GR.	HATCH		
3.0 EVALUATION[2/]							
Crop Advisory Committees[3/] Planning and Coordination	40	40					
Wheat	180	30	150[4/]				
Fruits and Nuts (other than citrus)	500	100	400				
Corn	100		100				
Soybeans	70	40	30				
Grasses	100	50	50				
Beans (Phaseolus)	40		40				
Cotton	60	20	40				
Sorghum (incl. sweet sorghum & Millets	60	20	40				
Potatoes	100	30	70				
Tomatoes	90		90				
Alfalfa	100	20	80				
New Crops[5/]	400	80	320				

Table 11.3. Continued...

KEY OBJECTIVES	S&E TOTAL	ARS INTERNAL	ARS EXTRAMURAL	CSRS SPECIAL GR.	CSRS HATCH	ES	HE
3.0 EVALUATION (continued...)							
Sweet Potatoes	40		40				
Peanuts	30		30				
Oilseeds (other than those listed)	80		80				
Vegetables (other than those listed)	80		80				
Citrus	50		50				
Peas	40		40				
Oats	80	30	50				
Legumes (other than those listed)	60		60				
Sugar Crops (other than those listed)	60		60				
Ornamentals	100		100				
Barley	20	20					
Rice	20	20					
TOTALS	2,500	500	2,000				

1/ Projected increases in 1981 dollars.

Table 11.3. Continued...

KEY OBJECTIVE: EVALUATION

2/ There are two principal reasons for evaluating germplasm in our collections: (a) to identify gaps in the range of genetic diversity that might be filled through acquisition efforts; and (b) to enhance the usability of the collection through a more intelligent response capability as users identify their specific needs. The ultimate objective is to have germplasm used in crop-improvement research and development. For germplasm to be used, it must be shown to be useful. Evaluation identifies useful attributes. These attributes include those traits (phenotypic expressions) that are of interest to the developer of the crop--environmental stresses and biotic stresses (pests); quality traits; yield and yield constraint traits.

This work is continuous, although a major start is needed for each crop. The priorities of traits to evaluate and the order of germplasm within a crop can be determined by the appropriate crop-advisory committee (see footnote 2/ below). As one crop is finished for the first round of evaluation, the funds can be "rolled over" to the next crop in the priority schedule (see footnote 3/ below).

3/ Please refer to the "Interim Report to the NPGRB on Crop Advisory Committees" of April 1981. This was accepted by the Board as its policy recommendation on crop-advisory committees. Page 3 of the Report specifies the work of the committees. Points 1 and 2 specifically are important to this evaluation section. the work begins after the plans are established and priorities among crops have been established by the NPGC/NPGRB. The crop-advisory committees suggest the appropriate personnel and locations for this work. The crop-advisory committees monitor the work in cooperation with the crop curators.

4/Funds for these evaluations are spent in concert with the appropriate crop-advisory committee. All of this work should be viewed as "mission-oriented" and not subject to open-investigator discretion. The appropriate funding mechanism should be used to accomplish this disciplined and controlled work most effectively; thus the bulk of the work should be done either by ARS scientists or through carefully monitored ARS cooperative agreements.

5/ The objective is to identify and develop new crops that can provide new raw materials or those for which we are now depending on other countries and which can be grown on underutilized lands. Research involves acquisition of germplasm, screening (evaluation) for desirable agronomic and compositional characteristics, and agronomic and utilization research to develop promising candidates for commercial use. Screening objectives (compositional characteristics) are hydrocarbons for fuels and rubber and biomass production (energy), industrial oils, gums, waxes, proteins (total and amino-acid composition), feedstocks and fiber (paper pulp, cordage). Agronomic screening objectives are yield, performance on marginal lands (mine spoils, sludged areas, high-salt soils, acid soils, poorly drained soils) and efficient water use. New crops also include medical, advanced pharmaceutical, and advanced industrial materials and feedstocks.

Table 11.4. Plant Germplasm--FY 1983 Required Science and Education Increases1/ ($000) within Key Objectives

KEY OBJECTIVES	S&E TOTAL	ARS INTERNAL	ARS EXTRAMURAL	CSRS SPECIAL GR.	CSRS HATCH	ES	HE
4.0 GERMPLASM ENHANCEMENT2/							
Corn	150	40		30	80		
Wheat	150	40			110		
Soybeans	150	40		20	90		
Tomatoes	50	20			30		
Grasses (Range)	100	40		20	40		
Potatoes	50				50		
Beans	50			30	20		
Cotton	60	40			20		
Sorghum and Millets	50			30	20		
Alfalfas	60	30			30		
Sweet Potatoes	50	10			40		
Peanuts	50	30			20		
Oilseeds	60	10			50		

Table 11.4. Continued...

KEY OBJECTIVES	S&E TOTAL	ARS INTERNAL	ARS EXTRAMURAL	CSRS SPECIAL GR.	CSRS HATCH	ES	HE
Vegetables	80	20		30	30		
Peas	40			20	20		
Oats	60	60					
Legumes (other than those listed)	70	20			50		
Sugar Crops	60	40			20		
Rice	40	20			20		
Barley	50	20			30		
Ornamentals	70	20		20	30		
TOTALS	1,500	500		200	800		

1/ Projected increases in 1981 dollars.

2/ An effective germplasm program must ultimately be measured by increased crop productivity and decreased genetic vulnerability. Useful characteristics in germplasm from primitive varieties, landraces, or wild relatives of crop plants must be transferred to genetically and agronomically desirable backgrounds to enhance usefulness in further breeding and development of new and improved cultivars. This work bridges germplasm conservation and the use of germplasm. It requires curators of germplasm and crop breeders to cooperate to assure the promotion of germplasm toward usefulness and the two-way flow of materials (raw germplasm to breeders, improved germplasm into maintenance programs as well as to users) and information.

This work may well be a major portion of the crop improvement work in ARS in the near future, because it is essential to a national crops program insuring against the potential and serious problems of genetic vulnerability.

Table 11.5. Plant Germplasm--FY 1983 Required Science and Education Increases 1/ ($000) within Key Objectives

KEY OBJECTIVES	S&E TOTAL	ARS INTERNAL	ARS EXTRAMURAL	CSRS SPECIAL GR.	CSRS HATCH	ES	HE
5.0 RESEARCH ON THE CONSERVATION OF GENETIC DIVERSITY 2/							
Acquisition - Methods and International Cooperation 3/	200	130		30	40		
Maintenance Methods:							
Sampling Techniques	80	40			40		
Cytogenetic Studies	180	130			50		
Cryogenic Storage	60	60					
Clonal and Cellular Storage Methods 4/	80			80			
DNA Classification Method and DNA Storage 4/	100	20		20	60		
Research on In-situ Methods 4/	100	20			80		
TOTALS	800	400		130	270		

1/ Projected increases in 1981 dollars.

Table 11.5. Continued...

KEY OBJECTIVE: RESEARCH ON THE CONSERVATION OF GENETIC DIVERSITY

2/ To acquire, maintain, evaluate, and make readily accessible to plant breeders a maximal range of genetic diversity demands assurance, in every activity phase in this continuum, that diversity is not being lost. This calls for (a) research on the ecogeographic distribution of genetic diversity of crop species, statistical methods for (b) sampling diversity in field populations; (c) sampling-collected accessions slated for increase and/or regeneration of viability; and (d) sampling for specific evaluation plantings. It also requires research on optimal conditions for maintaining germplasm in storage with minimal loss of genetic diversity. New maintenance strategies may involve cell/tissue cultures, or perhaps eventually, DNA classification and maintenance.

This work is also coordinated by the crop-advisory committees.

3/ As previously stated, much of the material to be gathered is from foreign sources. Concerted and careful planning, directed by the crop-advisory committees and the NPGS Staff, is required to do this successfully. The work is often delicate and cannot be repeated. ARS and some of the SAES's have the appropriate personnel to accomplish this task.

4/ The research in this section is required to support the expected technological changes in the type of germplasm to be maintained and to make it more useful.

Table 11.6. Plant Germplasm--FY 1983 Required Science and Education Increases 1/ ($000) within Key Objectives

KEY OBJECTIVES	S&E TOTAL	ARS INTERNAL	ARS EXTRAMURAL	CSRS SPECIAL GR.	CSRS HATCH	ES	HE
6.0 INFORMATION MANAGEMENT 2/							
NPGS Computer-assisted Teleconferences 3/	100	100					
GRIP Computer System	350	350					
Terminals for NPGS, IMC, and Administration	50	50					
TOTALS	500	500					

1/ Projected increases in 1981 dollars.

2/ Information on germplasm resources, as with the germplasm itself, must be readily accessible to all having a bona fide need for it. In this respect, information reflects all aspects of germplasm conservation and use, from acquisition to distribution. Data on germplasm resources allow gaps in collections to be identified, the status of diversity to be monitored, and vulnerability to be assessed. An effective information system provides curators and users with the means to assemble, organize, analyze, and present data in support of decisions on planning, implementing, and managing germplasm activities.

3/ CDSD has already begun work on special "electronic mail" systems. These may be extended to the NPGS for more effective communication within this complex system. Further, the new and very promising technology of computer-assisted teleconferences is being proposed. This work would link sites and the appropriate committees for planning and tracking programs. This can be done effective with a small incremental cost. The likely savings in travel can assist in paying for this technology.

Table 11.7. Plant Germplasm--FY 1983 Required Science and Education Increases[1/] ($000) within Key Objectives

KEY OBJECTIVES	S&E TOTAL	ARS INTERNAL	ARS EXTRAMURAL	CSRS SPECIAL GR.	CSRS HATCH	ES	HE
7.0 MONITORING GENETIC VULNERABILITY[2/]							
U.S./Domestic:							
Systems and Methods	410	60	50	100	200		
Monitoring Data Operation and Data Communication	460	60			100	300	
U.S./Foreign:							
Coordination and Methods	20	20					
Monitoring Data Operation and Data Communication	110	60	50				
TOTALS	1,000	200	100	100	300	300	

1/ Projected increases in 1981 dollars.

Table 11.7. Continued...

KEY OBJECTIVE: MONITORING GENETIC VULNERABILITY

2/ Catastrophic crop losses brought on by insect and disease epidemics or extremes in major weather patterns (widespread drought, floods, temperature ranges beyond normal, wind) can be minimized through the collective genetic diversity represented in numerous varieties of a given major crop grown on farmers' fields. Each variety, highly competitive in terms of yield and quality, would differ from every other in genetic make-up affecting resistance for biological and environmental stresses that have been identified for a given growing area as having a certain probability level of incidence. Monitoring probability of shifts in weather patterns and pest build-ups will permit protective action through recommended shifts in varietal composition of a crop in a potential danger zone. Monitoring pest populations and assessing probability of their reaching epidemic levels can provide time for chemical or other control measures to be used to bolster genetic resistance. The monitoring can be arranged in three forms:

(a) Continual assessment of probability that stressful conditions (biological and environmental) can occur; matching these risks with the genetic diversity that can minimize losses.

(b) Development of early-warning systems that alert crop consultants, extension personnel, and growers of the need to implement protective methods (chemical, biological, cultural practices, etc.) that will further minimize loss.

(c) Continued provision of input into national planning and review activities on research and development of advanced practices for crop protection (such as IPM).

Table 11.8. Plant Germplasm--FY 1983 Required Science and Education Increases1/ ($000) within Key Objectives

KEY OBJECTIVES	S&E TOTAL	ARS INTERNAL	ARS EXTRAMURAL	CSRS SPECIAL GR.	CSRS HATCH	ES	HE
8.0 TRAINING2/							
NPGS Orientation and Special Short Courses	50	50					
NPGS Long-term Training--Biology and Other Disciplines for Plant Germplasm	250						250
TOTALS	300	50					250

1/ Projected increases in 1981 dollars.

2/ Scientists and technicians engaged in plant-genetic resources work require special training in field collecting, curating germplasm collections, design and management of increase and evaluation planting, data collecting and information management, and communications skills.

C. 1989-97

Implemenetation of the recommendations contained elsewhere in this report and the budget requirements for the period 1983-88, will prepare the NPGS with the necessary service and essential research base it needs for the next decade. It will then be essential that the efforts within the NPGS include the kinds of imaginative research necessary to prepare the System for the next century. It would be foolhardy to attempt to project exactly what research thrusts will appear most promising in that time period, but it would seem clear that (1) NSSL would need to assume a leadership role in the development of advanced technology for the long-term storage of seeds and/or tissues; (2) germplasm enhancement efforts will include the application of advances in genetic engineering; (3) plant exploration will be based upon sophisticated (computer-aided) assessments of evaluation efforts and ecogeographic research; and (4) important new biochemical traits will be identified which require evaluation.

Total projected increases for the period 1989-97 are indicated in table 12. It will be the responsibility of the management components (in consultation with advisory components) of the NPGS to refine these projections to meet the specific needs of that time period.

Table 12. Plant Germplasm--Total Required Science and Education Increases[1/] ($000) by Thrust Areas, FY's 1989-97.

KEY OBJECTIVES	Fiscal Year 1989	1990	1991	1992	1993	1994	1995	1996	1997	Total
1.0 ACQUISITION	150	100	90	80	80	80	70	50	60	760
2.0 MAINTENANCE	150	130	100	90	80	70	60	60	70	810
3.0 EVALUATION	100	80	80	80	70	60	50	70	60	650
4.0 GERMPLASM ENHANCEMENT	300	300	300	300	330	350	350	350	350	2,930
5.0 RESEARCH ON THE CONSERVATION OF GENETIC DIVERSITY	200	300	350	400	400	420	450	450	450	3,420
6.0 INFORMATION MANAGEMENT	40	30	30	20	20	20	20	20	10	210
7.0 MONITORING GENETIC VULNERABILITY	30	30	20	--	--	--	--	--	--	80
8.0 TRAINING	30	30	30	30	20	--	--	--	--	140
SUBTOTALS (RECURRING)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	9,000
9.0 FACILITIES ASSESSMENT, CONSTRUCTION, PROCUREMENT	628 [2/]	2,876 [3/]	2,742 [4/]	--	--	--	--	--	--	6,246
TOTALS	1,628	3,876	3,742	1,000	1,000	1,000	1,000	1,000	1,000	15,246

1/ Projected increases in 1981 dollars.

Table 12. Continued...

2/ Planning and construction of Plant Germplasm Center (Phase II) at Beltsville, Maryland. Facilities to accommodate plant introduction and quarantine activities now at Glen Dale, Maryland. These activities are cooperative and involve both ARS and APHIS. New APHIS facilities are already being planned at the Beltsville location.

28,500 sq. ft. 1,900 sq. ft. (wet laboratory) @ $125/sq. ft.	=	$ 237,500
5,850 sq. ft. (dry laboratory) @ $100/sq. ft.	=	585,000
750 sq. ft. (office) @ $65/sq. ft.	=	48,750
		$ 286,835
Plus 12 percent/year escalation (2 years)	=	72,971
Plus 8 percent/year escalation (6 years)	=	211,161
		$ 570,967
Plus 10 percent Engineering and Supervision		57,097
		$ 628,064

3/ Planning and construction of Plant Germplasm Center (Phase III) at Beltsville, Maryland. Greenhouse facilities to support plant introduction and quarantine activities (Phase II).

20,000 sq. ft. (greenhouse)		
1,600 sq. ft. (negative pressure) @ $70/sq. ft.	=	$ 112,000
18,400 sq. ft. (standard) @ $60/sq. ft.	=	1,104,000
		$1,216,000
Plus 12 percent/year escalation (2 years)		309,350
Plus 8 percent/year escalation (7 years)		1,088,832
		$2,614,182
Plus 10 percent Engineering and Supervision		261,418
		$2,875,600

Table 12. Continued...

4/ Facility to provide storage processing, evaluation, and office space for the soybean collection, its full-time curator and support personnel.

10,000 sq. ft.		
6,000 sq. ft. (seed storage) @ $125/sq. ft	=	$ 750,000
3,000 sq. ft. (laboratory) @ $100/sq. ft.	=	300,000
1,000 sq. ft. (office) @ $65/sq. ft.	=	65,000
		$1,115,000
Plus 12 percent/year escalation (2 years)		283,656
Plus 8 percent/year escalation (7 years)		998,394
Plus 4 percent/year escalation (1 year)		95,882
		$2,492,932
Plus 10 percent Engineering and Supervision		249,293
		$2,742,225

APPENDIX

Appendix A.

CURATOR ROLE

A. General Responsibilities

1. A curator is an individual who has accepted specific responsibility to physically maintain, protect, control access to, and distribute specific plant germplasm.

2. The same crop curator has the attendant responsibility to gather, maintain, and process data necessary to register, maintain, and describe the germplasm, and to systematically communicate information about the germplasm to the user community.

3. Role definition - restricted authority. All of the above responsibilities are undertaken within the general and specific policies and guidelines established by the NPGC and approved by the most senior administrator of the participating agencies and organizations.

B. Specific Responsibilities

1. Work with the designated CAC's concerning all aspects of the preservation and use of the data information and physical germplasm.

2. Adhere to the current NPGS plant-registry system for the national inventory of all germplasm.

3. Maintain the germplasm under recommended storage conditions and by acceptable seed-rejuvenation plantings as indicated or by protected, well-managed plant repositories in the case of clonally propagated species.

4. Place in the germplasm-maintenance system, designated types of germplasm in keeping with the advice of germplasm CAC's and appropriate NTA's.

5. Must <u>not</u> discard, combine, destroy, nor eliminate elements of the collection nor physically transfer nor relinquish responsibility for the whole collection on his own volition. When changes in program personnel, physical facilities, or administrative policy occur, or other constraints develop that would affect the physical collection or the data about the collection and place continued discharge of the above responsibilities in question or place in jeopardy in any way the physical collection or the attendant data, the curator or his administrator must notify the regional coordinator responsible for the germplasm of that specific crop as soon as possible.

6. Work closely with the DBM 1/ on all information and communication aspects as a critical part of the curator's responsibility.

7. Distribute information and reasonable amounts of the germplasm under care to bona fide research scientists and institutions upon request and without charge.

8. Maintain the germplasm so that loss of variability is minimized. These approaches to and methods of curation are subject to review by the CAC, and if necessary, the NPGC.

9. Keeping to the responsibilities and restrictions designated above, the curator may delegate functions as he sees fit but such delegation must be clearly under the curator's direct control and general supervision.

1/ DBM is used synonomously with the Data Base Administrative Unit proposed by the GRIP team.